THE ART OF PRACTICAL MEASURING

Eaſily Perform'd,

By a Two Foot RULE,

Which ſlides to a FOOT.

On which is the *beſt Meaſure* of *Round Timber* the Common way. Alſo, the *true Meaſure* of *Round, Square*, or other *Timber* or *Stone, Board, Glaſs, Paving, Painting, Wainſcot*, &c. *Gauging* of *Cask*, and *Gauging* and *Incbing* of *Tuns*.

CONTAINING

Brief Inſtructions in *Decimal Arithmetick*. The beſt way of uſing the *Logarithms* according to Mr. *Townley*. The Uſe of a new *Diagonal Scale*, of 100 parts in a quarter of an Inch, applied to *Gunter's* Chain.

AND LASTLY,

Some Uſeful Directions in *Dialling*, not hitherto Publiſhed.

By *H. C.* Gent.

The Third Edition, Corrected.

LONDON, Printed for *Thomas Bennet*, at the *Half-Moon* in St. *Paul's* Church-yard, 1706.

THE

ART

OF

TO THE READER.

THE general Approbation of this Rule, hath caused me to review the Book. I have explained some things, and added others, which I thought useful.

Whether Mr. Townley's contrivance of the Indices be treated of any where, but in Sir Jonas Moor's Mathematical Compendium, I could never learn; nevertheless, the Extraction of the Square and Cube Roots of Decimals, according to that contrivance, being there wanting, I have given you it here, so that the Root of a Decimal, whose Logarithms hath such an Index, is found with equal ease, as that of a whole Number.

I have shewn how to find the Logarithm to any Number of six places, in Mr. Wingate's Tabulæ Logarithmicæ (omitted in the explanation of the Tables) by the differences at the bottom, and a slip of this Rule, it supplying the place of a Table of proportional parts, which adds much to the usefulness of the said Book, in giving the Logarithm of any Number, as far as a Million, with little trouble.

The Gauging of Tuns is here shewn according to the Modern Practice of Inching. I have given you a near way of measuring a Solid that tapereth strait, as also of finding the Total Content of the Conical Tun and Stand, from Mr. Everard; whose Numbers for ten Inches difference of Diameters, for the Parabola and Conoeid, I have also inserted.

The making the most useful Dials, viz. the Horizontal, and the upright ones, is rendred here easie and certain, especially the North faces; some of which are equally needful

as the South. *And because it is not commendable to put more or fewer hours on a Plane, than the Sun (supposing no obstacle) will at some time of the year shine on; or to make the Style over long or over short, I have given you a way to find both by an easie Calculation. And lest any thing should be wanting, that might seem necessary to this Treatise, I have added Tables of the Suns Declination.*

Lastly, here is added by Mr. John Warner, *(whose care, in the directing the Impression, I here thankfully acknowledge) a curious Scheme of both sides of the Rule and of the Scale.*

1. *And that I may leave nothing obscure or uncertain, know, Courteous Reader, that the Subdivisions mentioned page 32, line 15, are those on the Square line, from 4 to 10, which were not on the first made Rules, but put on after, to their great Improvement.*

2. *That the words (from 10 to 40 into 4 parts) p. 24. l. 6. are to be understood from 10 to 40,* each whole *into four parts.*

3. *In the Instrument described, p. 75. let the Rule said to be six inches long, be nine inches long; however, something longer than the Semidiameter, for there needs no exact proportion. Also, let the Diameter be at least an inch distant from the edge of the Board, that there may be space to fix the one Rule to the other behind the Center.*

4. *The Ascentional difference mentioned thrice. cap. 9. of Dialling, must be that at the greatest Declination of the Sun.*

5. *If any think that the Style is too short, as directed page 95, he may take the length of the Hour line to the outward border, and proceed, as directed there; so the shadow at the shortest, shall reach so far.*

For other faults, I refer you to the Printed Errata, intreating your favourable Censure, it being natural for Man to Err. I may also alledge this in excuse, That living far from the Press, I saw not the Sheets till they were wrought off, and so past Correction any other way.

Henry Coggeshall.

THE

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THE

THE

PREFACE.

Lthough the way of Measure by this Rule is so easie, that many, without the Art of Arithmedo understand and use it, as far as their partioccasions require; yet it is convenient for a urer to have some skill therein, especially in the irst parts thereof.

here are Books of that subject, written by divers, to d at easie Rates, whereof only the later Authors of Decimal Arithmetick and Logarithms. By the er of these, the troublesome way of working with ulgar Fraction is avoided; by the other, Multiion and Division are easily performed by Addition ubstraction.

th these, since they first came into use, have improved. The four Rules in Division of Decidelivered by Mr. *Wingate* in his first Treatises rithmetick, are by Mr. *Kersy* reduced to one, which ws after. Mr. *Townley*'s Indices free the operation ecimals, from multiplicity of Rules, and give you Rate or Value of them directly; so that the most l parts of Arithmetick are rendered far more spee- nd easie.

I have therefore here premiſed a ſhort Treatiſe
Decimal Arithmetick, and of the nature and uſe
the Logarithms; noting firſt, that the beſt way (
my opinion) of reading Decimals, is, as you r
whole Numbers, giving them the name of the va
of the laſt figure to the right hand. To which p
poſe you may call them more eaſie, if inſtead of Te
parts, Hundredth parts, Thouſandth parts, T
thouſandth parts, *&c.* you ſay Tenths, Ce
Milleſmes, Decimilleſms, Centimilleſms, Millemille
&c. as this .00165, I read 165 Centimilleſms,
ſo any other.

T H

The ART of PRACTICAL MEASURING Eaſily Perform'd, &c.

PART I.

The Introduction.

THE Art of meaſuring depends wholly upon Geometry and Arithmetick; it is therefore abſolutely neceſſary for a Meaſurer to have a mpetent Skill in both.

1. In Geometry; it is requiſite that he know the ree Kinds of Quantity, as a Line, a Superficies, and olid. That a Line hath only length; That a Super- ies hath length and bredth; That a Solid hath length, dth and depth.

Moreover, That each kind of Quantity is meaſured ſome common Meaſure thereunto aſſigned, as a Line meaſured by lineal Inches, Feet, Yards, Poles, &c. Superficies by ſuperficial or ſquare Inches, and a Solid ſolid or cubical Inches: And when 'tis known how any Inches, Poles, &c. are contained in a Line, the ngth of that Line is ſaid to be known; ſo when 'tis own how many ſquare Inches are con ained within a Superficies

Superficies, the Content or Area of that Superfi is ſaid to be known. And laſtly, when 'tis known h many ſolid Inches are contained within any Solid, t the Content of that is likewiſe known. But in th preſuppoſe my Reader to be competently vers'd, oth wiſe I would refer him to the firſt Book of *Euc* Elements, and to ſome others; alſo, I would ad him to get *Spidel*'s Geometrical Extractions, or *N ton*'s Mathemetical Elements, Printed in the y 1660. in *Quarto*, the firſt part of which is to our purpoſe, but the two latter Parts are Aſtronomi

2. In Arithmetick, he ought to underſtand Additi Subtraction, Multiplication, Diviſion and the Ex ction of Roots in whole Numbers, and the ſame in F ctions, both Vulgar and Decimal; but if he be to herein, let him get *Wingate*'s Arithmetick of the 5th, 6 or 7th Edition, as 'tis enlarged by Mr. *Kerſey*.

And for his further help therein, I have here inſer a brief Account of the Nature and Uſe of Decimal Ari metick and Logarithms.

SECTION 1.

Notation, Addition, Subtraction Multiplication and D viſion in Decimals, with whole and mixt Numbers.

A Decimal is the Numerator of a Fraction whoſe D nominator is an Unit, with one or more Cyphers, whi Denominator is not expreſſed, it being known by t Numerator.

For ſo many places as are in the Numerator, or D cimal, ſo many Cyphers are ſuppoſed to be adjoyn to the Unit in the Denominator. It ought to have Point before it thus . as a Badge whereby it may known: being otherwiſe written as a whole Numbe

Therefore a Decimal of one place is Tenth, as t .2 is two tenths. Of two places is Cents or hundr parts, as this .02 Of three is Milleſmes or thouſa parts, as this .002 &c. The ſignificant Figures be

by the Cyphers into places of leſs value, and the
es decreaſing from Unit in a ten fold Proportion.
thus. Call ſuch as have a ſignificant figure next
the point, as theſe .3, .25, .732, *&c.* Decimals
e firſt rank or rate. Such as have one Cypher af-
e Point, as theſe .08, .0134, *&c.* Decimals of the
d rank or rate. Such as have two Cyphers after
oint, Decimals of the third rate, *&c.* The con-
nce whereof you will find afterward.
he work is the ſame as in whole Numbers: yet
theſe Directions.

If you uſe a whole Number with mixt Numbers
ecimals; Let it have always a Point after it.

In Addition and Subtraction; the Points prefixt
e Decimals muſt be ſet under one another, by
n means the Units in the whole or mixt Numbers
alſo under one another.

In Subtraction, Although a Cypher at the right
of a Decimal is of no value, (as theſe .5, .50,
are no more than 5 tenths, or an half) yet if the
nals conſiſt not of an equal Number of places, or
of the Numbers be a whole Number you muſt
Cyphers, or ſuppoſe them annexed.

Examples of Addition.

75	19.2	.17	32.78	.34
6	4.68	.89	12.	.178
				.84
35	23.88	1.06	44.78	.7
				2.058

Examples of Subtraction.

22.75	19.2	107.	48.16
9.6	4.68	8.93	17.
13.15	14.52	98.07	31.16

Multiplication.

1. But in Multiplication, ſet them as if they
whole Numbers, and ſo multiply them: Cutting
from the Product found ſo many figures to the
hand, as there are places in the Decimals, both o
Multiplicand, and the Multiplier; ſo the reſid
the whole part of the Product, and the figures cu
the Decimal.

2. If the Product hath not ſo many places, as
are places of Decimal parts in both Numbers;
ply the deficient places with Cyphers prefixt to
left hand.

Examples.

46.25	87	564.	.0375	.76
35.	.9	.25	.05	8.
23125	.783	2820	.001875	6.08
13875		1128		
1618.75		141.00		

By theſe Examples you ſee how the whole p
the Product is diſtinguiſh'd from the Decima
thereof.

Diviſion.

In Diviſion it is ſomething harder to diſtingui
whole part of the Quotient from the Decima
thereof.

Firſt, Annex Cyphers to the Dividend, at pl
or leave ſpace for them, that the Diviſion may b
tinued to a ſufficient Quotient. Then place the
ſor under it according to the old way of Div
but ſo as if they were both whole Numbers:
obſerve well what place or degree of the Di
ſtandeth over the place of Units in the Diviſor:

r theſe places be real, or only ſuppoſed; of the ſame
ree or place is the firſt figure in the Quotient.
ich being once noted, you need not regard the
nts, nor the Cyphers at either end of the Diviſor,
more; but continue the Diviſion, as if both were
le Numbers.
ee here the degrees of Decimals as they ſtand in
r natural order, which may be continued either
from Unit.

uſ. Hund. Tens. Unit. Tenth pts. Hund. pts. Thouſ. pts.

o. 100. 10. 1. .1 .01 .001, &c.

have here ſet down ſome Examples, wherein you
ſee how the Diviſor is placed under the Dividend
ne firſt Queſtion, and alſo the two firſt figures in
Quotient.

id. 180.000 (30. &c. *Divid.* 1.75000 (.02. &c.
iſ. 5.875 *Diviſ.* 63.

id. 1.00000 (.083 &c. *Divid.* .748000 (91. &c.
iſ. 12. *Diviſ.* .0082

Divid. 972000 (21. &c.
Diviſ. .45

the two laſt Examples: Although there be nei-
Unit-place in the Diviſor, nor (if there were)
figure over it in the Dividend: yet by ſuppoſing
places continued to the left hand, or ſupplying them
Cyphers; you will ſee that the firſt place in the
tient is the place of Tens.
account that way of Diviſion the beſt: In which,
(upon examination by multiplying the Diviſor
he anſwering figure from the left hand toward the
t) you have found the fit figure to be put in the
tient; You proceed in your Diviſion to multiply
Diviſor by the anſwering figure, beginning with
figure in the Diviſor next the right hand If the

figure over it in the Dividend be not great enough
take the Product out of it; call it so many Tens, m
than it is, as will make it great enough, but no mo
and then substract; setting the remaining figure ove
and cancel the said figure: And for the Tens add
call the Product of the next figure so many Units m
than it is. Admit the Product 36 must be taken out
2; call the 2, 42; and subtract. Suppose the n
Product is 18; call it 22, &c. which way you m
fewest figures; and is no more burthen to the memo
than ordinary Multiplication.

*To multiply or divide any whole number, mix'd Numbe
Decimal by* 10, 100, 1000, &c. *by removing the Poi*

To multiply: Remove the Point so many pla
to the right hand, as there are Cyphers in the Mu
plier: If figures be wanting, supply them with C
phers, as here, 27. by 10, is 270,: .13 by 100
13.; .02 by 10 is .2.

To divide: Remove the point so many places
the left hand, as there are Cyphers in the Divi
If places be wanting, supply them with Cypher
here. 27. by 10 is 2.7.: .13 by 100, is .0013: o
10, is .002.

SECT. 2.

Logarithms.

Purposing to give you the Solution of some of
Questions in this Book by those excellent Numbers,
Logarithms; Take these Directions for the better
derstanding the Nature and Use of them

They are artificial Numbers fitted to the Natu
for the ease of Calculation; and are Printed in
bles having two Columns. One hath the Nat
Number; against it in the other is his Logarithm:
that the Logarithm of a whole Number is e
found.

he Tables begin at 1, whose Log. is 0,00000: and
ch commonly to 10,000: consisting every one of 8
res though, (unless in great Numbers), we seldom
above six: if the figures left out exceed 50, we put
nit to the sixth), So *Ulacq* and *Gellibrand*. Sir *Jonas*
r also as far: to which are annexed differences: by
help of which, and a Table of proportional parts
oyned, you are directed to find the Logarithm
ny Number to 100, 000. But these are but of
laces.

Mr. *Wingate*, in his *Tabulæ Logarithmicæ*, hath them
100, 000, with differences also: whereby making a
portion (which is done speedily by one slip of this
e), you have the Logarithms as far as 1,000,000;
portable Volume for the Pocket. A Book, which
mmend to any that delight in Arithmetick.

The first figure, called the Index (which is common,
eperated by a Point; better left out, except in the
hundred; as in the late Printed Tables), shews
many figures the answering Number, if whole;
he whole part thereof, if it hath a Decimal an-
ed, consisteth of: which are always more by one
n the Index. So 0. is the Index of one figure;
f two figures; 2. of three; 3. of four, *&c.*

Also according to the excellent way of Mr. *Chri-*
her Townely, cited by Sir *Jonas Moor* in his Mathe-
tical Compendium; The Log. of a Decimal is the
e, as if it were a whole Number, with this dire-
on for the Index.

If the Decimal be of the first rate, the Index is 9;
f the second rate, the Index is 8; if of the third
e, the Index is 7, *&c.* Or, the Index is the Com-
ment of the rate to Ten. *Viz.* of the distance of
first significant figure to the left hand, from the
nt or Unit: Which, I hope, you will understand,
you observe this following Table.

Where you see, That in the Perfect Numbers, the Index sheweth the Number of places in the whole Numbers, and in the whole part of the mixt, being always less by one, than the said places; but in Decimals, it sheweth the Rate, being the Complement thereof to Ten, not regarding the number of places.

Perf. Numb.	*Logs.*
3536.	3.54851
353.6	2.54851
35 36	1.54851
3.536	0.54851
Decimals.	*Logs.*
.3536	9.54851
.03536	8.54851
.003536	7.54851
.0003536	6.54851

If then you would have the Log. of any Numb find the Log. thereof in the Table, as if it where whol and prefix the Index answering the value.

And having a Log.; find the Number answering the Table; and by a Point fix the value according the Index.

To find a Log. to a Number of six places in the Tabul Logarithmicæ *by help of this Rule.*

Call the Differences at the bottom the Tabular D ferences. Having the Log. of the five first figur by the double Scale on your Rule, set 10 to t Tabular Difference; against your sixth figure is proportional part to be added to the Log. bef found.

To find a number of six places answering a Log. given.

Find the Number of five places, answering the L in the Table, next less to the given Log. subtract said Log. out of the given Log. call the remain proper Difference, then by the double Scale on y Rule, set 10 to the Tabular Difference; against proper Difference on the second, is your sixth figur the first.

Note, That you must use all the eight figures in t case.

Whereas, before the aforeſaid contrivance of the
es by Mr. *Townly*; if one Number were perfect,
he other a Decimal, there was a different Rule in
y operation for them: But by the ſaid contrivance,
is now ſufficient; I will give Examples only, in
h one Number is a Decimal: with theſe two
ctions.

In the Log. which anſwereth the Queſtion (whe-
it be a Sum, Remainer, Half, *&c.*) If the Index
en or above, neglect or cancel the ſaid figure in
lace of Tens.

Where you are ordered to Subtract a greater Log.
of a leſs; Add ten to the Index of the leſs, and
ſubtract.

1 *Multiplication.*

dd the Logs. of the two, or
Numbers to be multiplied;
Sum is the Log. of the Product,
2 multiplied by the Decimal
the Product is 3.

12.		1.07918
By .25		9.39794
3.*X*		0.47712

may alſo be done, where there are but two, by
acting the Arithmetical Complement of the Log.
e of them out of the Log. of the other; The re-
der is the Log. of the Product.

hich Arithme-
Complement is
emainer of every
e, (including the
x), to 9; except
e laſt ſignificant
e to the right
, whoſe remai-
you muſt take to
As in theſe
Examples.

Numb.		
2.	0.30103	*Log.*
.5	9.69897	*Ar. Compl.*
Numb.		
80.	1.90309	*Log.*
.0125	8.09691	*Ar. Compl.*
Numb.		
100.	2.00000	*Log.*
.01	8.00000	*Ar. Compl.*

2. *Diviſion.*

Subtract the Log. of the Diviſor out of the Log. the Dividend (whether of the two be greater or leſs;) The remainer is the Log. of the Quotient. So 12 divided by the Decimal .25; The Quotient is 48.

12.	1.079	
By .25	9.397	
48.	1.682	

It may alſo very conveniently be done, by add the Ar Compl. of the Log. of the Diviſor to the L of the Dividend; The Sum is the Log. of the Q tient, as followeth.

3. *The Rule of Three direct.*

1. Add the Logarithms of the ſecond and th from the Sum ſubtract the Log. of the firſt; the mainer is the Log. of the fourth.

2. A better way: Add the Ar. Compl. of the L of the firſt to the Logarithms of the ſecond and th The Sum is the Log. of the fourth. *Example*, If .25 give 16.; What ſhall 12. give?

Anſwer, 768.

Ar. Compl.	.25	0.60
	16.	1.20
	12.	1.07
	768.	2.88

But in the Inverſe Rule: Add the Ar. Compl. of the Log. of the t to the Logarithms of the firſt and ſecond; the Su the Log. of the fourth. Thus are reſolv'd the (ſtions wrought on the double Scale.

But for thoſe in this Book, where there is a d cate proportion, as in Timber-Meaſure and Gag If the firſt and third Numbers be on the Square There are general or fixt Logarithms belonging t firſt Numbers; to which if you add the Log. of ſecond, and the Log. of the third twice, the Su all four is the Log. of the fourth.

If the ſecond and fourth Numbers be on the S Line: To the Ar. Compl. of the Log. of th add the Log. of the third, and the Log. of

ſe

d twice; Half the Sum is the Log. of the h.

4. *The Square Root.*

lf the Log. of the Number given is the full Log. e Square Root.

the Number be a Decimal, add	.25	19.39794
o the Index, and then halve	.5	9.69897

s here.

5. *The Cube Root.*

e third part of the Log. of the Number given is ull Log. of the Cube Root.

the Number be a Decimal, add	.25	29.39794
y to the Index, and then di-	.63	9.79931

by 3, as here.

To find a mean Proportional between two Numbers.

d their Logs. together: Half the Sum is the Log. mean proportional.

hen one is a Decimal, If the	12.	1.07918
f the Indices be ten (as here,)	.25	9.39794
ve; cast away ten, and then		X0 47712
it: if it be not ten, add ten	1.732	0.23856

and then halve it.

To find two, or more, mean Proportionals between two Numbers.

is, in case of a Decimal, was something perplex'd, u may see in Mr. *Wingate's Artificial Arithmetick.* now, by the aforesaid contrivance of Mr. *Townly*, e as it is useful.

tract the Log. of the less Num-	12.	1.07918
ut of the Log. of the greater:	.25	9.39794
remainer divide by a Number		1.68124
r by one than the Number of		42031

sought; as here by 4 for three

s.

This

This Quotient added to the Log. of the leſs Number; The Sum is the Log. of the firſt mean. To which adding again the ſaid Quotient; The Sum is the Log. of the ſecond mean. And ſo forward for as many means, as the Quotient was at firſt ordered for.

	Means.	
		9.39
		42
1	.658	9.81
		42
2	1.732	0.23
		42
3	4.556	0.65

8. *To find the Log. of a Vulgar Fraction.*

Subtract the Log. of the Denominator out of Log. of the Numerator; The remainer is the Log a Decimal equivalent to the ſaid Vulgar Fraction.

$\frac{3}{4}$	0.47
$\frac{1}{4}$	0.60
.75	9.87

9. *To find the Log of a Number with a Vulgar Fraction annex'd.*

Change the Number into an improper Fraction, multiplying the whole Number by the Denomi of the Fraction. and adding the Numerator to Product; The Sum is the Numerator of the improper Fraction.

Then ſubtract the Log. of the Denominator out of the Log. of the Numerator, as before; The remainer is the Log. of the ſaid Number with a Decimal, equal to the ſaid Vulgar Fraction, annex'd.

	12 $\frac{1}{4}$	
$\frac{49}{4}$		1.6
		0.6
	12.25.	1.0

I have, as an *Appendix* to this part, adjoyne uſual Decimal Tables, and compriſed them into Yet the uſe of them is as eaſie, as if they we ſingle.

The Integers, or Wholes, are ſet on the top the parts follow in order, with their Decimals anne

A TA

TABLE I.

TABLE of Englifh Coin, *a Pound ſterling* } *Integer.*
Alſo Troy Weight, *an Ounce.* }

Shillings and Decimals.	Pence with Farthings.	Decimals:	Grains.
.95	3	.0489583	
.9	2	.0479166	23
.85	1	.046875	
.8	11	.0458333	22
.75	3	.0447916	
.7	2	.04375	21
.65	1	.0427083	
.6	10	.0416666	20
.55	3	.040625	
.5	2	.0395833	19
.45	1	.0385416	
.4	9	.0375	18
.35	3	.0364583	
.3	2	.0354166	17
.25	1	.034375	
.2	8	.0333333	16
.15	3	.0322916	
.1	2	.03125	15
.05	1	.0302083	
	7	.0291666	14
	3	.028125	
	2	.0270833	13
	1	.0260416	
	6	.025	12
	3	.0239583	
	2	.0229166	11
	1	.021875	

The Reſidue of the Table.		
Pence with Farthings.	Decimals	Grains.
5	.0208333	10
3	.8197916	
2	.01875	9
1	.0177083	
4	.0166666	8
3	.015625	
2	.0145833	7
1	.0135416	
3	.0125	6
3	.0114583	
2	.0104166	5
1	.009375	
2	.0083333	4
3	.0072916	
2	.00625	3
1	.0052083	
1	.0041666	2
3	.003125	1
2	.0020833	1/2 = 1/4
1	.0010416	
1/2	.0005208	

TABLE II.

Averdupois *great Weight, One Hundred at* 112 *l. In*

Quarters.	Decimals.
3	.75
2	.5
1	.25

Pounds.	Decimals.
27	.2410714
26	.2321428
25	.2232143
24	.2142857
23	.2053571
22	.1962286
21	.1875
20	.1785714
19	.1696428
18	.1607143
17	.1517857
16	.1428571
15	.1339286
14	.125
13	.1160714
12	.1071428
11	.0982143
10	.0892857
9	.0803571
8	.0714286
7	.0625
6	.0535714
5	.0446428
4	.0357143
3	.0267857
2	.0178571
1	.0089286

The Residue of the Table.

Ounces.	Decimals.
15	.0083705
14	.0078126
13	.0072545
12	.0066964
11	.0061384
10	.0055803
9	.0050223
8	.0044643
7	.0039062
6	.0033482
5	.0027901
4	.0022321
3	.0016741
2	.0011161
1	.000558

Quarters.	Decimals.
3	.0004185
2	.000279
1	.0001395

TABLE III.

Averdupois *little Weight*, one *Pound* } *Integer.*
Long measure, one *Yard* or *Ell* }

Decimals	Qtrs with Nails.
.9375	3
.875	2
.8125	1
.75	3
.6875	3
.625	2
.5625	1
.5	2
.4375	3
.375	2
.3125	1
.25	1
.1875	3
.125	2
.0625	1

The Residue of the Table.

Drams.	Decimals.	Qtrs of Nail.
15	.05859375	
14	.0546875	
13	.0507812	
12	.046875	3
11	.0429687	
10	.0390625	
9	.0351562	
8	.03125	2
7	.0273437	
6	.0234375	1
5	.0195312	
4	.015625	1
3	.0117187	
2	.0078125	
1	.0039062	

Quarters.	Decimals.
3	.0029297
2	.0019531
1	.0009765

TABLE IV.

Liquid Measure, one Gallon } *Integer.*
Dry Measure, one Quarter. }

Pints.	Decimals.	Bushels.
7	.875	7
6	.75	6
5	.625	5
4	.5	4
3	.375	3
2	.25	2
1	.125	1

Quarters.	Decimals.	Pecks.
3	.09375	3
2	.0625	2
1	.03125	1

Decimals.	Quarters of a Peck.
.0234375	3
.015625	2
.0078125	1

Decimals.	Pints.
.0058594	3
.0039063	2
.0019531	1

TABLE V.

Dozens, one Gross } *Integer.*
Time, one Year }
Long Meas. 1 Foot }
Pence, one Shilling }

Dozens. Months.	Decimal.	Inches Pence.
11	.9166667	11
10	.8333333	10
9	.75	9
8	.6666667	8
7	.5833333	7
6	.5	6
5	.4166667	5
4	.3333333	4
3	.25	3
2	.1666667	2
1	.0833333	1

Parts.	Decimal.	Quarters and Farth.
11	.0763889	
10	.0694444	
9	.0625	3
8	.0555555	
7	.0486111	
6	.0416667	2
5	.0347222	
4	.0277778	
3	.0208333	1
2	.0138889	
1	.0069444	

Days

Days belonging to the Table of Time.

Days.	Decimals.	Days.	Decimals.
30	.08219178	15	.0410959
29	.079452	14	.0383562
28	.0767123	13	.0356164
27	.0739726	12	.0328767
26	.0712329	11	.030137
25	.0684931	10	.0273972
24	.0657534	9	.0246575
23	.0630137	8	.0219178
22	.060274	7	.0191781
21	0575342	6	.0164383
20	.0547945	5	.0136986
19	.0520548	4	.0109589
18	.0493151	3	.0082192
17	0465753	2	.0054794
16	.0438356	1	.0027397

To bring Decimals into known Parts.

Multiply the Number of parts in one Integer; and the Decimal together: From the product cut off so many figures to the right hand as are in the Decimal (as you are directed in Multiplication of Decimals) The residue to the left hand are the parts sought: and the Figures cut off are a Decimal of one of those parts, to be reduced the same way into the next less parts, if there be any, or if there be need. If nothing be left to the left hand; there is not one of those parts in that Decimal: Therefore account it cut off, and proceed to find the next less parts, as before.

The making these Tables is by dividing the Numerator of the Vulgar Fraction, which represents the parts, by the Denominator; the Quotient is the Decimal. So $\frac{11}{20}$ being the vulgar Fraction of Eleven Shillings or Penny weight: If you divide 11 by 20; The Quotient .55 is the Decimal: So that half the Number of Shillings or penny weight is the Decimal. Also $\frac{26}{960}$ being the vulgar Fraction of 6 *d.* $\frac{1}{2}$. or of 26 Farthings: If you divide 26 by 960; The Quotient .0270833, &c. is the Decimal.

Yet you shall not need Division for every Decimal; for some are found by halving the Integer or 1: and so continually: So are found the Decimal of one half, one quarter, one half quarter, *&c.* Some are found by halving a Decimal before found: So half the Decimal of a Shilling is the Decimal of Six pence: half of that, the Decimal of three pence, *&c.* Also one third part of the decimal of a Shilling, is the decimal of four pence, and the half of that, the decimal of two pence, *&c* and the double of it the decimal of eight pence. Likewise the Sum of two decimals is the decimal of the Sum of the two Fractions whose decimals they are, and the difference is the decimal of their difference.

Some of these are of one place and some of more: Few Tables have them to above Seven: and most ordinary questions may be resolved to a sufficient exactness, if you use but four: remembring the direction above given, *viz.* If the first figure of those left out exceed 5; to add an Unit to the last of those you retain.

If the answer of a question be in Money; Three places of Decimals give it to near a Farthing, as is shewn after, *Part* 4. *Prop.* 5.

Now for the use of them in a Question or two.

1. At 5 *s.* 3 *d.*, the Ounce; what cost 7 Ounces, 3 penny weights and 19. grains.

Having added the Decimals of the parts, the question will stand thus: o *l.* o *l.*

1 : 0.2645833 :: 7.1895833 : 1.902

The

The Product or Answer is 1 *l.*9022, *&c.* Which is 1 *l.* 18 *s.* 0 *d.* 2 *f.* near.

If you leave out the three last figures in each Decimal, with the condition above-mentioned; The Numbers are o *l.* o

1 : 0.2646 :: 7'1896,

and the answer is 1 *l.*9023, *&c.* differing from the other, inconsiderably.

2. To compute simple Interest for any Sum, Rate, and Time. Having put the parts, if there be any, into their Decimals: Multiply the Principal and the Rate; from the Product cut off the due Decimal, if any, and two places more for the Division by 100; This Product so ordered is the Interest due for one year; which if you multiply by the time (be it more or less than a year) The Product (the due Decimal cut off) is the Interest for that time.

Examp. 1. What is the Simple Interest of 132 *l.* 07 *s.* 6 *d.* for 2 *y.* 3 *m.* 22 *d.* at 6 *l.* in the hundred?

The Decimal of 7 *s.* 6 *d.* is .375: which being annexed to the whole pounds, the principal will be 132*l.*375: which multiplied by 6, and the Product ordered as directed, it will be 7.9425, or 7 pounds 18 shillings and 10 pence farthing near, for the Interest for one year. But that being not the Sum sought, Multiply the said 7.9425 and the time, *viz.* 2 *y.* 3103; The Product 18.3493 is the Interest sought, *viz.* 18 *l.* 06 *s.* 7 *d.* 3 *f.*

Ex. 2. What is the Interest of the said Sum for two Months and ten Days at the same rate? Multiply the said 7.9425 by .1941 the Decimal of the time; the Product 1 *l.* 5416 or 1 *l.* 10 *s.* 10 *d.* is the Interest sought.

But the great convenience of Decimals is, that their Logs. are so easily found; as is already shewn in this second Section. So that by the *Tabulæ Logarithmicæ* mentioned in the afore cited place, any question, whose Numbers (whether Whole, Mixt, or Decimals) ex-

ceed not six places, may be speedily resolved; Mr. *Townley*'s Indices of the Decimals freeing us from the perplexity of different Rules. As in the two last Examples.

To the Arith. Compl. of the Log. of 100, *viz.* 8.0000000 add the Logs. of the principal and of the rate; The Sum is the Log. of the Interest for one year. To which Log. if you add the Log. of the time, this Sum shall be the Log. of the Interest for the Time.

Or without seeking the Interest for one year: To the said Ar. Compl. add the Logs. of the Principal, Rate, and Time; The Sum shall be the Log. of the Interest demanded, as in the second Example.

	Example 1.	
100.	*Ar. Compl.* 8.	
132.375		2.1218059
6.		0.7781512
7.9425		0.8999571
2.3103		0.3636683
18.3495		1.2636254

	Example 2.	
100.	*Ar. Compl.* 8.	
132.375		2.1218059
6.		0.7781512
.1941		9.2880255
1.5416		0.1879826

3. Compound Interest for any Principal, Rate, and Time by the Logarithms.

In this Proposition the Excellency of those Numbers appears: such Questions being resolved by them with great ease and speed; but by Natural Arithmetick not without considerable time and trouble.

Deduct the Log. of 100 from the Log. of 100 and the rate added together, as 105, 106, *&c.*: The difference multiply by the time: From the Product cut off the Decimal, if there be any: The Remain add to the Logarithm of the Principal; The Sum is the Logarithm of the Principal and Interest required.

Example

Example.

Let the Principal, rate, and time be as in the former of the two laſt Queſtions. Purſuing the rule, as you ſee in the Margin; The Sum of the Principal and compound Intereſt is 151 *l.*09*s.*00*d.*

The Difference	253058
The Time	2.3103
The Product	584639.8974
132.375	2.1218059
	158639
151.45	2.1802698

It ſeems by this, that the Intereſt of 100 *l.* at 6*l.* *per cent.* by the Year, is not fully amounted to 3*l.* in 6 Months: for if you multiply the aforeſaid difference by .5, the decimal of 6 months; and, having cut off one place, add the reſidue to the Log. of 100; The Sum will be 2.0126529: Which is the Log. of 102.956. that is 102 *l.* 19 *s.* 01 *d.* 1 *f.*

I will add two or three Examples more, which I hope will be ſufficient.

1. What is the value of 28 Ounces 6 penny weight and 15 grains of Gold, at 3 *l.* 3 *s.* 6 *d.* the Ounce? Annexing the Decimals to the Integers, the Numbers ſtand thus,

o. *l.*	o. *l.*
1 : 3.175 ::	28.33125 : 89.952.
l. s. d. f.	3.175 0.5017437
Facit, 89 . 19 . 00 . 2.	28.33125 1.4522657
	89.952 1.9540094

2. If 4 . 9 . 12 of Gold coſt 14 . 10 . 9; What is that the Ounce?

o. *l.*	o. *l.*
The Numbers are 4.475 : 14.51875 ::	1 : 3.2444
l s. d. f. 4.475 *Ar. Compl.*	9.3492070
Facit, 3 . 04 . 10 . 2. 14.51875	1.1619291
3.2444	.5111361

3. At

3. At 6 *s.* 3*d.* the Ounce; how much Silver Plate will 5 *l.* 3 *s.* 6 *d.* Buy?

	l.	o.	*l.*	o.
The Numbers are	0.3125 :	1	: : 5.175	: 16.56

o. *p.* *gr.* .3125 *Ar. Compl.* 0.5051
Facit, 16. 11. 05 near. 5.175 0.7139
16.56 1.2190

I have taken but six figures in this last Example. If I had used no more in the other, the difference would have been little or inconsiderable: as you may find if you please to give your self that small trouble.

These thus premised, I shall come next to the Description and uses of the Rule in several Measures. Wherein I shall use these Vulgar Fractions, *viz.* $\frac{1}{4}$ one quarter: $\frac{1}{2}$ one half: $\frac{3}{4}$ three quarters. The Decimals belonging to these, as they are immediate parts of the whole, are .25 for a quarter: .5 for a half: and .75 for three quarters.

But if they be parts of parts; other Decimals belong to them, as you see in the Tables.

THE

The ART of PRACTICAL MEASURING Eaſily Perform'd, &c.

PART II.

The Deſcription of the Rule.

UPon each Flat or ſide of the Rule are four Lines, two next the outward edges, which are es of Meaſure; and two next the inward edges, ich are Lines of Proportion.

One ſide (as in *Fig.* I.) next the outward edges, hath Line of Inches divided into Halfs, Quarters, and lf Quarters, and figured from 1 to 12 on one piece he Rule; and from 12 to 24 on the other. Next the ward edges upon one piece, is a Line of Numbers in o lengths; The firſt from 1 at the beginning, to 1 the middle; The ſecond from 1 in the middle, to at the end. On theſe Rules it is thus divided, be-een 1 and 2 into 10 parts, and each tenth is again divided into 5 parts, from 2 to 3 the ſame, from o 4 into 10 and each tenth into two parts, and ſo on m 4 to 6, from 6 to 7 into 10 parts only, and ſo on 1 in the middle: and the ſecond Radius is divided actly like the firſt. But I have had ſome Rules that ve been more nicely ſubdivided, *viz.* from 1 to 3 ch p rt into 100, and from 3 to 6 each part into 50, d from 6 to 10 each part into 20.

Upon

Upon the other piece next adjoyning to the Li of Numbers, is a Line which I call the Square Li and (when the Meaſure of round Timber is concern the Girt Line, which Line is figured thus 4, 5, 6, 8, 9, 10, 20, 30, 40, this from 4 to 10 has each ten divided into 2 parts, and from 10 to 40 into 4 par alſo the diviſions 38 and 39 with their halfs and qua ters, are put on before 4 at the beginning of this Li and cut as in their proper places.

On the other Flat (*Fig.* II.) next the outwa edges, on one piece, is a Line of Inches divided each i to 10 parts for Gauging, *&c.* on the other, a Fo divided into 100 parts, and this I mean when I me tion Foot Meaſure, the beginnings of both th Lines are at the ends of the Rule, the ends, at t broad loop or middle, when the Rule is ſet to tw Foot.

Next the inward edges are two Lines of Numbe divided exactly as that on the other ſide, and theſe a called in this Book the *Double Scale.*

That piece to which the Braſs Loops are rivetted, call the *Fixt Rule*, the other the *Moveable.*

SECTION 1.

Of the Line of Numbers, commonly called Gunter's Li

The proper Numeration of this Line I account, at the beginning: and ſo by 10 in the middle, to 1 at the end.

But for the better underſtanding this Line: S here the Degrees of Number from Unit on either ſid as they ſtand on the Line: That is increaſing from l hand to right.

Thouſ. pts.	*Hund. pts.*	*Ten. pts.*	*Unit.*	*Tens.*	*Hund.*	*Tho*
.001	.01	.1	1.	10.	100.	100

Where you ſee, how they increaſe on one ſide fr Unit, and on the other ſide decreaſe from the ſa

a Tenfold proportion. So that if you ſet any one of
em at the beginning; the two next following ſhall
, one the middle, the other the end. As if you call
t the beginning one tenth; the middle ſhall be 1,
d the end 10. If you call one at the beginning 10,
e middle ſhall be 100, and the end 1000. But if it
not otherwiſe limited; account, as I ſaid before,
10. 100.

On that Line of Numbers, which is on the move-
e Rule, at theſe Numbers following may be Pricks,
the more ready finding them: They being firſt
mbers or centers, as they commonly call them.

At 9 for Yard-Meaſure.

At 12, four Points thus . ' . ., for Plank or Board,
d Glaſs.

At 144, alſo for Glaſs.

At 160, for Land-Meaſure.

At 272, (for the Decimal .25 may be omitted with-
t conſiderable errour) for Rod-Meaſure of Brick-
ll at 1 ¼ Brick thick.

At 204; for two Brick thick, and other Points or
ts for other thickneſſes, if deſired. The finding,
ereof is ſhewed after.

At 282 for Ale galon-meaſure in Square and Ob-
g Veſſels. And other may be ſupplied, as any hath
aſion for them.

SECT. 2.

Of the Square or Girt-line.

This is no more but one whole length of the Line
Numbers; but at a double Radius: it being exact-
qual to the Lines of Numbers on this Rule, which
in two lengths.

In the Numeration of it, when occaſion requires,
muſt account 10, 20, 30; to be 1, 2, 3: as alſo
5, 6, 7, &c. to be 40, 50, 60, 70, &c.

At

At 12 on this Line, let there be four Pricks, as 12 on the Line of Numbers: At 17. 15 the W Point, marked W. At 18. 95 the Ale-point, ma ed A. These are put on by the Workman.

At 10. 635 may be a Point like the Gauge-poi for finding the true content of a round Solid by Girt.

At 13. 54 such another, for finding the Conten a Cylinder by the Diameter.

At 41. 57 another, to shew how many Inche length make a Foot solid at any Girt or Square exceeding 40 Inches.

These may be put on thus:

For the first: Set 12 on the Square line to 14 the Line of Numbers; against 11 on the Line of N bers mark this Point.

The second: Set 12 on the Sq. Line to 11 on Line of Numbers; against 14 on the Line of N bers mark this Point.

The third: Set 12 on the Sq. Line to one at the ginning of the Line of Numbers; against 12 on Line of Numbers mark this Point.

These, or any other mentioned hereafter, cut a sharp-pointed Pen-knife in two places, as the G Points, and strike in with your finger, some Sall cole fine ground with Linseed-Oil; and then the Rule clean.

Both these Lines are put on from the Logarithm

SECT. 3.

The general Use of Double Scales.

It is chiefly for the working of the Rule of Th or having three Numbers given to find a fourth portional. It including Multiplication and Divi for there is no other difference, than that in these an Unit is one of the three.

To find this fourth: Set the first Number on the rſt Rule, to the ſecond Number on the ſecond Rule; gainſt the third Number on the firſt Rule is the ourth on the ſecond Rule.

Example. If 2 give 3; what ſhall 6 give? Set 2 n the firſt, to 3 on the ſecond; againſt 6 on the firſt, 9 on the ſecond.

Wherefore when I ſay, Set 2 to 3; againſt 6 is 9: mean as in the above ſet Example, though I name ot the firſt or ſecond Rule. Yet you may note, that he *moveable*, or *longer Rule* is, for the moſt part, he *firſt*, whether ſide ſoever of the two you work on.

So in Multiplication: 1 being the firſt Number; et 1 to either of the two Numbers to be multiplied; eſt to the neareſt) againſt the other is the Pro-uct.

In Diviſion; The Diviſor being the firſt Number: et it either to 1, or to the Dividend; againſt the her is the Quotient. Examples of both you will eet with after.

By this the Arithmetick of the Rule is eaſily un-erſtood: the firſt Numbers being Diviſors. Only here the Sq. Line is uſed; the Numbers on the Sq. ine muſt be ſquared, or multiplied by themſelves: and eir Squares uſed in every reſpect, as if they were the umbers themſelves, as you will after ſee.

SECT. 4.

Set the Square-line to his Squares, and thereby, To Square a number not exceeding 100, *and to find the Square root of a Number not exceeding* 10, 000.

1. Set 10 on the Sq. line to 1 at the beginning of e Line of Numbers: both which if you account 1; u have, on the Line of Numbers, the Squares from to 16. Alſo at this ſet it is moſt convenient to take e Squares from 1000 to 1600: *viz.* by accounting on the Sq. line 10, and 1 at the beginning 100.

2. Set 10 on the Sq. line to 1 in the middle, ac counting 10 on the Sq. line 10, and 1 in the midd 100; you have the Squares on the Line of Numbe from 16 to 1000; and of this you will have moſt uſe.

3. Set 10 on the Sq. line to 10 at the end, accoun ing 10 on the Sq. line 100, and 10 at the end 10,000 So have you on the Line of Numbers the Squares fro 1600 to 10,000: And againſt all the Squares, at ev ry ſet, his own root.

Examp. I would know what is the Sq. root of 38 Set 10 on the Sq. line to 1 in the middle, (accordi to the ſecond Direction) againſt 380 on the Line Numbers is 19.5 near.

SECT. 5.

A Direction concerning the ſhortneſs of the Lines on the Ru

1. On the Double Scale: If you uſe half of eith the ſecond or third Number inſtead of the whole, y will have half the content. If you uſe the half both, you have only a quarter of the content. T firſt muſt remain whole.

2. On the Sq. line-ſide: If you uſe half that Nu ber that is on the Line of Numbers, commonly t ſecond; (being ordinarily lengths or depths) you ha half the content.

If half of that on the Sq. line, commonly the thir (being ordinarily Sides of Squares, or Diameter you have a quarter of the content. If you halve the both, you have only one eighth of the content.

3. In finding a mean Proportional, half the e tremes give half the means; and a quarter gives quarter. Theſe may be more exactly defined, a multiplied accordingly.

This Direction alſo may be uſeful to you in worki by the Sq. line, when at any time the third Numb ſtandeth beyond the Line of Numbers: and removi the firſt to the ſecond in the other length, ſets it fa ther off. For then, 1.

1. If the first be a fixt Number on the Sq. line; as 2, and the Gage-Points, *&c.* Set it to half the second, and double the content.

2. If the first and second be fixt, as in finding the superficial content by the Diameter, use half the third Number being on the Sq. line, and quadruple (or multiply by 4) the content;

These Products are the fourth Numbers sought.

The ART of PRACTICAL MEASURING Eaſily Perform'd, &c.

PART III.

PROP. I.

To Meaſure Round Timber the common Way.

MEaſure the length in feet and half feet: a (if the Cuſtom of Agreement be ſo) in Qu ters; Then back again half way, where G the Tree with a ſmall Cord or Chalk line: Doub this Line twice very even. This fourth part of t Circuit (which in this Treatiſe I call the Girt) Me ſure in Inches, Halves, and Quarters of Inches. A this obſerve, That the lengths be given in feet: t Girts and ſides of Squares in Inches.

So have you three Numbers given, *viz.* 12 alwa the firſt: the length always the ſecond, and the G or ſide of the Square the third.

To come now to the Rule: Set 12 on the Gi line to the length on the Line of Numbers; agai the Girt on the Girt line is the content on the Li of Numbers. And this is the general Rule.

Now there being two Caſes: One, when, at t firſt ſet, the Girt is againſt ſome part of the Line Numbers: The other, when it is not, ſo that

nuſt be removed; I will give you ſeveral Examples f both. Obſerving, that the Vulgar Fractions be-ore mentioned; as alſo all Decimals, always follow he Number they belong to, before the name thereof.

Caſe 1.

Examples.

1. A Tree is 20 f. long, and 15 inches Girt: et 12 to 20.; againſt 15. is 31. $\frac{1}{4}$ f. or 31 f. and quarter.

2. A Length is 8 $\frac{1}{2}$ f. The Girt is 35 $\frac{3}{4}$ inches. Set 2 to 8 $\frac{1}{2}$; againſt 35 $\frac{3}{4}$ is 75 f. and almoſt an half.

3. A Length is 15 f. The Girt 42 $\frac{1}{2}$ inches: Set 12 15; againſt 42 $\frac{1}{2}$ is 188 f.

4. A Rail is 15 f. long: The Girt 3 inches: Set 2 to 15; againſt 3 is 9 tenths of a foot, and more.

5. A Length is 9 $\frac{1}{2}$ f. The Girt 39 $\frac{3}{4}$ inches: Set 12 9 $\frac{1}{2}$; againſt 39 $\frac{3}{4}$ at the beginning of the Girt-line 104 f.

6. The Length is 0.62 f. The Girt 35 inches: Set 2 to the Decimal .62 in the firſt Length; againſt 35 5 $\frac{1}{4}$ f. which may ſerve for a ſhort cut of a Tree.

If this length had been propounded 7 $\frac{1}{2}$ inches, it uſt have been turned into Foot-meaſure thus: On e double Scale, ſet 12 to 100; againſt the Length inches is the length in Foot-meaſure: but if it lies efore you, meaſure it by the Line of Foot-meaſure n the Rule.

Caſe 2.

If at the firſt Set the Girt is beyond the Line of umbers, remove 12 to the length in the other length ereof. Which caſe may alſo happen in Gauging *&c.*

Examp. 1. The length is 18 f. The Girt 31 inches: et 12 to 18 in the firſt length; againſt 31 is 120 f.

2. A Rail is 15 f. long: The Girt 3 $\frac{1}{2}$ inches: Set 2 to 15 in the firſt length; againſt 3 $\frac{1}{2}$ is $\frac{1}{4}$ f. and a ttle more, *viz.* 1.27 f.

3. A wrong is 6 ½ f. long: and 4 ¼ in Girt: Set 12 to 6 ½ in the second length; against 4 ¼ is above eight tenths of a foot. These Examples may be sufficient.

Note 1.

If you would find the content of a great piece of Timber immediately in loads at 40 f. to the load; use half the Girt instead of the whole. *Example.* A length is 15 f. The Girt 42 ½ inches. Set 12 to 15; against 21 ¼ is 47: whereof the 4 is 4 loads, and the 7 is 28 f.

By this way (if your Rule be not subdivided as before) you measure Timber, whose Girt is above 40 inches: as also the piece in *Case* 1. *Ex.* 5. which without the said subdivisions, and placing 38 and ½ before 4 at the beginning, are not resolved by the general Rule.

But if you would have the content of these peices in feet: Multiply the content found, by 4 the square of 2, by which you divided your Girt: So 47 multiplied by 4 is 188 f.

Note 2.

To what length soever you set 12; 17 will stand to the double thereof, 8 ½ to half thereof, both a little over: Also 24 will stand to the quadruple thereof, and 6 to a quarter thereof exactly: and the same proportion the content bears to the length at any of these Girts: *viz.* at 17 inches Girt; the content is double to the length: at 8 ½ inches Girt; the content is but half the length, *&c.*

Note 3.

If you would find these contents by Natural Arithmetick: seeing 12 and the Girt, *viz.* the first and third Numbers are on the Square line: According to a hint given in *Sect.* 3. of *Part* II. Multiply the Square of the

Girt

t by the length; and divide the Product by 144 Square of 12, which is your conſtant Diviſor; e Quotient is the content.

So in *Ex.* 1. *Caſe* 1. the Square of 15. *viz.* 225. ltiplied by 20; and the Product 4500, divided by 4 the Square of 12; the Quotient is 31. 25 the tent

By the Logs. To this general g. 7.84164, Add the Log of length and the Log. of the t twice; The Sum is, The Log. of the Content.

Gen. Log.		7.84164
20		1.30103
15	1.17609	
	1.17609	
31.25		1.49485

PROP. II.

rue Meaſure of Round Timber or Stone by the Girt.

Becauſe this common way of Meaſuring round Tim- giveth not a true Content, but always too little ough it ſtill be generally uſed) I have given you a nt, and ſhewn, how you may put it on the Rule: ich ſetting to the length inſtead of 12; the Girt ll point you out a true Content, accounting it a linder, as the ſaid common way alſo doth.

Examp. Let the length be 10 f. the Girt 15 inches: the ſaid point (which you may call the true point) 10; againſt 15 you have 20 f. leſs by about one th: whereas the common way giveth but 15 f. and tle above an half.

The general Log. anſwering this point is 7.94652 be uſed as before.

Thus far by the Length and Girt: I ſhall only add; t the common Meaſure is to the true, as 11 to 14. that if you ſet 11 on the double Scale to any Num- of Feet or Loads meaſured the common way; 14 ll poi: to the true content of the ſame: and if ſet 14 to any true content; againſt 11 is the con- t the common way.

PROP.

PROP. III.

Having the length of a Cylinder in Feet, and the Diam in Inches; to find the content in Feet.

Set the point 13.54 to the length; againſt the Di meter is the content. *Examp.* Let the length be 10 and the Diameter 20 inches: Set 13.54 to 10; again 20 is 21.82 f. The gen. Log. is 7.73676 to be uſed before.

PROP. IV.

Having the length of a Square ſolid in Feet, and the ſid the Square in inches, to find the content in Feet.

Set 12 to the length; againſt the ſide of the Squa is the Content. The Caſes are as in round Timbe The Examples alſo will ſerve, accounting the G to be ſides of Squares.

PROP. V.

To find a mean Proportional between two Numbers.

Set the greater of the two Numbers on the Sq. L to the ſame on the line of Numbers; againſt the on the Line of Numbers is the mean proportional the Sq. Line.

Or ſet the leſs on the Sq line to the ſame the Line of Numbers; againſt the greater on the L of Numbers is the mean proportional on the S line. One of theſe will not fail. Examples follo in the next.

PROP. VI.

Unequal Squared Solids.

Meaſure the length in Feet: The breadth and dep in inches. Then find a mean proportional betwe the breadth and depth, as is taught next following.

t is the ſide of a Square equal to the Baſe or end: ich having found, meaſure the piece as ſquare nber.

Examp. In Timber, whoſe length let be 10 f. breadth 21 in. The depth 8 ½ in. Set 21 to 21, inſt 8 ½ on the Line of Numbers is 13.36: or 13 a rter and half quarter near. Or ſet 8 ½ to 8 ½, inſt 21 on the Line of Numbers is the ſaid 13.36: en ſetting 12 to 10, againſt 13.36 is 12.4 f.

Examp. In Stone, which let be 6. 35 f. long, ½ in. broad, and 5.7 in. deep. Set 36 ½ to the ſame; inſt 5.7 on the Line of Numbers is 14, and ſomething rt of an half. Then ſet 12 to 6.35; againſt this n is 9.2 f. near.

This mean, in caſe of a Fraction, ſhall give you no ble: For if with a Pencil, Chalk, or any thing t may be wiped out without damage to your e (let it not be Ink) you may make a fine mark on Sq. line at this mean; and then ſet 12 to the gth: This mark, without defining it, ſhall point out r content.

PROP. VII.

Solids of a Triangular Baſe.

ind a mean proportional between the Baſe and f the Perpendicular, or between the Perpendicular half the Baſe, both meaſured in inches. This n is the ſide of a Square equal to the Triangle. en ſet 12 to the length in feet; againſt this ſide is Content.

f two ſides of a Triangle be equal; the unequal may be the Baſe. If the three ſides be unequal, longeſt ſide is commonly the Baſe: From whence neareſt diſtance to the oppoſite angle is the Perdicular.

PROP.

PROP. VIII.

Solids whose Bases have many equal Sides and equal Ang

These Bases are regular Figures. Having the len in Feet: and a side in Inches; Get the Perpendicu from the Center to a side also in Inches: So shall mean Proportional between the Perpendicular and the sum of the sides be the side of a Square equal to Base: which having found; Measure it as square Timb

Examp. A piece of Timber of eight sides is 10 long, The side 12 inches: the perpendicular 14 48 which you may call 14 $\frac{1}{2}$. Set 14 $\frac{1}{2}$ to 14 $\frac{1}{2}$; agai 48, half the Sum of the Sides on the line of Numb is 26.4. on the Sq. line, or there make a Mark. Th set 12 to 10; against this mark is 48 f. and a li more than a quarter.

And thus much of these ways of Timber-measu which being the main occasion of the Rule, and depending on any thing which followeth, I have se the first place.

PROP. IX.

Having the Girt; To find the side of the Square equal t

This and the three following Propositions wrought on the double Scale: Yet I have here joyned them for their affinity with Timber-measu And the proportional Numbers given in them are re dy cut on the Rule, and give Contents to an exactn sufficient in any concerns of Timber.

As 7. to 7.9; So the Girt to the side of the Squa equal. Let the Girt be 15 inches: On the Dou Scale: Set 7. to 7.9; against 15 is 16.9 near. If y set 12 to the length in feet; this side shall point ou true Cylindrical Content.

PRO

PROP. X.

ing the Girt, To find the side of the Square within near.

s 10 to 9, so the Girt to the side of the Square
in near. *Examp.* Set 10 to 9; against 15 is
. And so much will such a piece bear square.
y which you may know, before a piece be hewn,
many whole Boards or Plank, of any thickness
be had out of it.
rom hence also you may see, That the Girt, though
han the side of the Square equal; yet is greater
the side of the Square within: Toward which
Timber is hewn, before it can serve to any square
; which may be one reason of the continuance of
aid common way: Of which Opinion I find also
Henry Phillips to be, in a Treatise on this Sub-

PROP. XI.

ving the Diameter; To find the side of the Square within near.

s 1 to .707; or to excuse a cut there, As 8.5 to
being points equivalent near) so the Diameter
e side of the Square within near.
t the Diameter be 19.1 *viz.* the Diameter of 60
s Circumference. Set 8.5 to 6; against 19.1 is
near.

PROP. XII.

nd how many Inches in length make a Foot Solid, at y Girt or side of Square not exceeding 40 Inches.

t the Girt or side of the Square on the Square-
o one at the beginning of the Line of Numbers;
st 41.57 are the Inches which make a Foot.
f you set 6 for Example to 1; against 41.57 is 48:
o many Inches in length make a Foot at 6 Inches
or side of Square.

And

And now having done with the Measure of ordi
ry Timber; Let me advertise any Reader that h
not seen much measured, that sometime he will
a great difference in the Girt of a Tree in the spac
a Foot, more or less; for the most part, where
or more Arms have been cut off: In such case it is
cessary to Girt the Tree twice, yea thrice, if there
cause, otherwise there will be loss to Buyer
Seller.

Also they say, the Buyer hath Privilege to
any where between the middle and the ground end
it be for his advantage.

PROP. XIII.

True Measure of a Solid that tapereth strait.

Measure the length in feet: Note also the third
which you may find by setting 3 on the Double S
to the length; against 1 is the third part. If the
lid be round, measure the Diameters at each en
inches. Substract the less Diam. out of the grea
half the difference add to the less Diam.; the Sum
the Diam. in the middle of the piece.

1. Set 13.54 to the length; against the Diam. in
middle is a fourth Number.

2. Set 13.54 to the third part of the length; ag
half the difference is a fourth Number. Both t
fourth Numbers added together make the Content.

Examp. Let the length be 18 f. The third par
6. Let the greater Diam. be 24. The less 16.
difference is 8. Half the difference 4 added to the
Diam. 16; the Sum 20 is the Diam. in the middle.

Set 13.54 to 18; against 20 is 39.27 39.
Set 13.54 to 6; against 4 is .524 which
added to 39.27 maketh 39.794 or 39 f. 39
and above three quarters.

Note, That 13.54 must be set to 6 in the sec
length, as in the second Case of round-Timber mea
the common way.

If the ſolid be ſquare; uſe the ſides of the Squares at ch end, in every reſpect as the Diameters, mea- ring them in Inches, &c. But let 12 be your firſt umber.

If it be any other regular figure; uſe the ſides of the uares equal to each Baſe (found as is before ſhewn) the other: Taking alſo 12 for your firſt Number.

PROP. XIV.

The Meaſure of a Shell or Flitch of Timber.

If a piece be taken out of the middle of a round piece Timber from end to end; there will be left two ces, which they call Shells or Flitches.

To find a near Content of theſe after the common ay, with little trouble: Meaſure the length in feet: e round part, and the thickneſs in the middle (ta- n with a pair of Calepers) in inches.

Theſe two with a third part of the thickneſs add to- ther: a fourth part whereof account your Girt, and eaſure as round Timber the common way.

If, on the double Scale, you ſet 3 to 4: againſt the ickneſs is it ſelf with a third part added to it.

Examp. Let the length be 30 f. The round part .3 in. the thickneſs 7.2. in. Set 3 to 4; againſt 7.2 is 6. which added to 25.3, maketh 34.9. The fourth rt whereof is 8.7 near.

Or prick the ſaid 9.6 on the flat part in the middle om one ſide; and keeping the end of your Line at e other; Girt the whole round part, and to the ſaid ick: Double the line twice, and meaſure it in in- es for your Girt.

Set 12 to 30; againſt 8.7 is 15 foot and three arters.

Note, that this holds not ſo well in Sections cut r from the middle of the piece: In others, It giv- h a content ſomewhat leſs than the common way: hich may the better be born with, becauſe there is

more loſs in theſe than in other pieces. And as th
fall ſhort of the middle pieces in value, ſo a leſs ex
meaſure may ſerve.

PROP. XV.

Having the Diameter; To find the Area or Superficial Content of the Circle.

Set 1 on the Sq. line to .7854: Or to excuſe a c
there, ſet 11 to 9.5; againſt the Diam. is the ſupe
ficial Content.

Examp. Let the Diam. be 1.7 f. Set 11 to 9.5
againſt 1.7 is 2.27 f. near.

By the Logs. to the Log. of the Diam. twice, add this Log. 9.89509 being the Log. of the Decimal .7854; The Sum is the Log. of the ſuperficial Content.

1.7	0.2304	
	0.2304	
.7854		9.8950
2.27		0.3554

Note, That if the Diam. exceed not 3.57, 1 in t
middle is but 1; but if it exceeds 3.57, 1 in the mi
dle is 100.

Here you may have occaſion to make uſe of the D
rection given in *Sect.* 5. *Part* I.

Hence it is as eaſie, having the ſuperficial Conte
to find the Diam. or to caſt any Number into a Circ
So may the Gauge points be put on; for they bei
the Diameters of Circles, whoſe Area's are equal
the Number of Cubick inches in the Gallon of Wi
or Ale reſpectively: If you ſet the Rule as above, y
will ſee the Wine point ſtand againſt 231, and t
Ale point againſt 282.

PROP. XVI.

Cask-Gauging.

The figures of theſe Veſſels being uncertain, t
ſtaves of ſome being more circular from head to bun
and ſo more capacious than other; The late Gaug
diſtinguiſh them into four kinds: The Sphæroi
who

whoſe ſtaves are moſt arching, and this contains moſt: The Conick whoſe ſtaves from head to bung are ſtrait (if any ſuch can be made,) and this contains leaſt: The Parabola whoſe ſtaves are arching, but nearer to the Sphæroid than to the Conick: The Conoid, whoſe ſtaves are arching, but nearer to the Conick than to the Sphæroid. All theſe may have the ſame dimenſions of length and Diameters, yet differ conſiderably in the Contents.

Mr. *Everard* in his abſolute piece, *Stereometry made eaſie*, Printed 1684. giveth a Diagram of all the Kinds, and Rules for each, both by Arithmetick and the ſliding Rule, except for the Conick, there being (as he ſaith) none ſuch made; yet the figure thereof is uſeful to the diſtinguiſhing the other.

Mr. *Wingate* took no notice of theſe ſeveral kinds, his general way applied to this Rule is thus.

Meaſure the length of the Veſſel within, the Diam. at the Bung, and the Diam. at the Head in inches and tenths. Subſtract the Diam. of the Head out of that at the Bung; the difference multiply by 7, and divide the Product by 10. on the Rule eaſily thus: On the double Scale ſet 10 to the difference; againſt 7 the Quotient, which is 7 tenths of the difference.

Theſe added to the leſs Diam. The Sum is an æquated Diam.

Then ſet the Gauge Point, whether of Wine or Ale, to the Length; againſt the æquated Diam. is the Content in Gallons.

Mr. *Everard* agreeth with Mr. *Wingate* upon 7 tenths near for ten inches difference of Diameters, and accounts them to the Sphæroid: In other differences of Diameters they differ more.

His Numbers for ten inches difference are; for the Sphæroid 7.01; for the Parabola 6.39; for the Conoid 5.62.

In other differences, the Rule differs ſomething from his Table, to which I refer you.

To find the Content of a Cask in all these kinds, l
the Length be 34.5 : the Diam. at the Bung 29.4
that at the Head 25.3 : This deducted out of that
the Bung, the Remainder or difference is 4.1.

Set 10 to 4.1; against 7. is 2.87 for the Sphæroid
against 6.39 or 6.4 is 2.62 for the Parabola : again
5.62 is 2.3 for the Conoid.

These added severally to 25.3, the Sum is 28.1
for the Sphæroid: 27.92 for the Parabola : 27.6 fo
the Conoid, for æquated Diameters.

Example. Set the Ale-point to 34.5 ; again
28.17 is 76.25 Gal. for the first : against 27.92 is 74.
Gal. for the second : against 27.6 is 73.2 Gal. for th
third : such is the difference (upon account of the
shape) by these Numbers.

By the Logs. To this general Log. 7.53148, for Wine : To this 7.44484, for Ale: Add the Log. of the length, and the Log. of the æquated Diam. twice; the sum is the Log. of the Content : as you see here for Wine.

	Gen. Log.	7.5314
	34.5	1.5378
	28.17	1.4497
		1.4497
	93.08	1.9688

The Fractions are thus reduced to pints: On the double Scale set 10 to 8; against the Decimal are the Pints answering.

The Sphæroid may be known by the round swelling of the staves from one Head to another. If you lay a strait Rule on the Hoops of a Cask from the Head toward the Bung, and it toucheth, or very near, the Hoop next the Head and that next the Bung, you may account it a Conoid. If the Rule librate upon the middle Hoops, like the beam of a ballance, and yet the staves not much swelling; account it a Parabola.

Besides the shape of these Vessels, I have observed two things not noted by any to my knowledge, which may render the Gauging them uncertain. One is the joyning staves of unequal thickness, not taking care to smooth

ſmooth them within, which may cauſe an Errour of ſome tenths in taking the Bung. Diameter.

The other this. The Head Diam. may be taken too great, though taken without, by reaſon of the paring away and ſmoothing the inward ſide of the Cask at each end, in order to the putting in the Heads. So that in reaſon it ſhould exceed the Diam. pointed out by the Staves, which is the true Diam. Both theſe I have ſeen in Casks, that have been cut aſunder.

PROP. XVII.

Gauging and Inching of Tuns.

Theſe are of ſeveral figures, but moſt are ſquare or round.

The ſquare are either equal ſided or unequal: both right angled, and may be conſidered as the ſame.

The round are either Cylindrical: *viz.* having the Diameters at top and bottom equal, (if any ſuch can be Hoopt) or Conical, whoſe Diameters at the top and bottom are unequal.

Alſo the Content may be required: either Total; or only of ſome Liquor contained in them.

The Content is ordinarily found firſt in Ale-gallons which are reduced to Beer-Barrels by dividing the Number of Gallons by 36: or to Ale-Barrels by diviſing the ſame by 32. Alſo a Barrel containeth 4 Firkins: So 9 Gallons of Beer: 8 Gallons of Ale make a Firkin. The Dimenſions, *viz.* Lengths, Breadths, Depths and Diameters are taken in Inches.

SECT 1.

Square Tuns.

On the double Scale ſet 282 (cut on theſe Rules) to either length or breadth; againſt the other is the Content in Gallons at 1 inch deep, which being reduced to Firkins and Barrels, as it will bear: By a continual

tinual addition, as we add pounds, ſhillings and pence; a Table may be made to any Number of inches deep.

Or if you you ſet 1 on the ſaid Scale to any depth in inches or this content; againſt the other is the Total content. Or multiply them by the Pen.

Examp. The length is 84 inches: the breadth 62 in. Set 282 to 62; againſt 84 in the firſt length is 18.47 Gal. Or 2 Firkins, 2 Gallons, and near an half of Ale: which you may add, as in the Margin.

In.	*B.*	*F.*	*G.*	*Pt.*
1	0	2	2	4
2	1	0	4	9
3	1	2	7	4
4	2	1	1	8
5	2	3	4	3
6	3	1	6	8
7	4	0	1	1

Let the depth be 26 in. Set 1 to 18.47: againſt 26. is 480.22, which is near a quarter.

By the Logs. To this Gen. Log. 7.54975 add the Logs. of the length and breadth; The Sum is the Log. of the Content at 1 inch deep.. And if to the you add the Log. of the depth; The Sum is the Log. of the whole content. Or if to the ſaid Ge Log. you add the Logs. of the length bredth and depth; The Sum is the Log. of the whole Content, without notice taken of the Content at 1 inch deep.

Gen. Log.	7.5497
84.	1.9242
62.	1.7923
18.47	1.2664
26.	1.4149
480.2	2.6813

Becauſe it is likely there will be Tenths of an Inc wet: On the double Scale ſet 10 to the Content gal. at 1 inch deep; againſt every tenth is his ow ſhare or part of the ſaid galons. Let the tenths be 6 Set 10 to 18.47; againſt 6 is 11 gal. belonging to tenths. They put no pints into the Table.

SEC

SECT. 2.

Cylindrical Tuns.

ving the Diam. of a Cylindrical Tun in Inches; To find the Content in Ale-Gallons at 1 Inch deep.

If the Diam. exceed not 40 inches, ſet the Ale-int to 1 in the middle; againſt the Diam. is the Con-nt; 1 in the middle being one gallon.

If the Diam. be above 40 inches: Set the ſaid point 10 at the end; againſt the Diam. is the Content, 1 the middle being 10 gallons.

Which Contents, being for 1 inch deep, may be ſt reduced, and then added continually for a Table: before it be reduced, multiplied by the depth for Total Content.

Or ſet the Ale-point to the depth; againſt the am. is the Total Content.

Examp. Let the Diam. be 58 in. Set the Ale point 10 at the end; againſt 58 is 9.37 gallons, the Con-nt at 1 inch deep: Let the depth be 36 in. Set the d point to 36; againſt 58 is 337 3 Gal. Or multi-the depth and Content at 1 inch deep, by the Rule Pen.

		Gen. Log.	7.44484
By the Logs. To the gen. Log.		58.	1.76343
Ale, add the Log. of the Diam.			1.76343
ice; The Sum is the Log. of		9.37	0.97170
Content at 1 inch deep.		36.	0.55630
And if you uſe the Log. of		337-3	2.52800
depth as in the former Se-on, you will have the whole Content.			

SECT. 3.

Conical Tuns.

1. To find the whole Content, proceed as in t Meaſure of a Solid that tapereth ſtrait, *Prop.* 12. o meaſure the depth alſo in inches; and inſtead of t point at 13.54, uſe the Ale-point, as alſo the gen. L uſed in the Section next above, which belongeth to it.

2. But in order to inching them; In ſmall ones Keelers they uſe only the Diam. in the middle account them as Cylinders. But in the larger, t take one in the middle of every Ten inches (beginn at the bottom) as alſo in the middle of the remain inches, except they be few, for then they account th to the laſt Ten, and take the Diam. in the midd Theſe Tens alſo they account as Cylinders.

3. Having found the Content anſwering the Di next the bottom, as is ſhewn *Sect.* 2; Put it into F kins and Barrels as it will bear, and by a contin addition (as in *Sect.* 1.) make up the ſaid Ten inches Then add the Content, anſwering the next Dia ter ſo reduced, inch by inch to the laſt Sum; and proceed till you have finiſhed.

4. In a regular Tun: Having the Diameters top and bottom, and the perpendicular depth, y may find any intermediate Diam thus:

Divide the difference of Diameters by the dep The Quotient multiply by any diſtance from the gr ter Diam. and ſubtract the Product from the Diam.; The Remainder is the Diam. at that diſtan Or multiply the Quotient by any diſtance from leſs Diam. and add the Product to the ſaid Di the Sum is the Diam. at that diſtance.

5. If the Tun be not exactly round: Meaſure t Diameters, where you obſerve the inequality: A them together, and take the half: Let the ſaid t Diameters be the longeſt and ſhorteſt, which will cr one another near at right Angles 6. B

6. Becauſe moſt large Tuns are fixed, and that drip-
g; for the better deſcent of the Liquor: The Square
s for the moſt part corner-wiſe; and the crowns
ottoms of the round ones commonly uneven and
gular; I adviſe you to fill up the ſaid crowns or
toms, as alſo the crowns of Coppers, by Meaſure
they be wholly covered.

Which may be done by a Veſſel of known quantity,
ou may Gauge one or a Pail: or by a true Gallon:
making which Directions are after given, which
alſo be otherwiſe ſerviceable) or in large Tuns
of all by both Veſſel or Pail, and Gallon; uſing
Veſſel firſt, and, when near covered, the Gallon.

. When the Bottom is covered, aſſign the Gauging-
e, (where the water covers a whole inch, if it
be: if not, make it up by meaſure) and fix it by
ark: And note the wet inches. Mark alſo the
s of the Diameters at the Superficies of the water:
lſo the Perpendicular, or neareſt diſtance of the
of the Staff from the water where the diſtance is
, and the length of the Staff from the Water in the
e place. Of all which having taken an exact ac-
nt: Let out the water, and from the aforeſaid
ks begin the meaſure of your ſeveral ten or twelve
es, and to the quantity before meaſured in, add
Contents inch by inch. The Content will be
t enough if you take a Diam. in the middle of eve-
welve inches.

. The ſe ſeveral ten or twelve inches, being under-
d to be of the Perpendicular depth: To avoid an
r, which in ſome caſes may be conſiderable:
he double Scale ſet the Perpendicular depth to
length of the Staff; againſt any Number of the ſaid
h is the Number anſwering on the Staff, which
ways greater than that of the depth.

. The proportional parts of any Content belonging
ny Diam. found as before, are to be ſet down, every
againſt his own Tenth, in a Column by them-
ſelves

ſelves againſt the Contents of the whole inches: To
uſed for the parts, which for the moſt part happen
be over and above the whole inches.

10. Reduce not the Decimals of a Gallon, (
addition of them being eaſie, and becauſe they m
not their Table to Pints) except perhaps in the p
portional Gallons.

11. The Diameters, whether long or ſhort,
meaſured by ſliding Rules numbred in inches, as t
are drawn out; (or in Gallons, which will ſave
ſome trouble) and are made to ſet together, (ſo as
be portable) to a great length.

What hath been ſaid of theſe Tuns may be und
ſtood of Coppers, Coolers, or any other Veſſels u
for Wort, either round or ſquare.

12. In an Oval Tun: Find a mean Proporti
between the longer and ſhorter Diam.; it is the Di
of a Circle equal to the Oval.

13. As for a true Gallon; To any Diam. in inc
which you chuſe, find the Content in inches, (as *Prop.*
By which divide 231 or 282 for Wine or Ale re
ctively: The Quotient found to the hundredth par
an inch is the depth. *Examp.* The Diam. is 6 in.

The Superficial Content anſwering is 28.27.
which, dividing 231 the Quotient is 8.17 the de
of the Wine Gallon By which again dividing
the Quotient 159.97 is the depth of the Ale Gallo

If you would have it ſquare, Divide the ſaid
Numbers by the ſquare of the ſide in inches. Let
ſide be 5 inches. By 25 divide 231 the Quot
9.24 is the depth of the Wine Gallon. And a
By 25 divide 282 the Quotient 11.28 is the dept
the Ale Gallon.

PR

PROP. XVIII.

To Gauge a Stand.

t may be accounted a close Conical Tun: and mea-
ed as a solid that tapereth strait, *Prop.* 13. Only (as
he Conical Tun) measure the depth also in inches:
instead of the point 13.54, use the Gauge-points,
the gen. Log. belonging to them. As in this Ex-
le in Ale.

Let the depth be 33 in. a third part thereof is 11.
the greater Diam. be 30 in: The less 24 in. The
erence is 6: The half-difference 3: which added
he less Diameter, the Sum 27 is the Diam. in the
dle.

. Set the Ale-point to 33 ? against 27 is 67 Gal.
. Set the said point to 11; against 3 is .27 or about
arter of a Gallon. So the Content of the Stand is
7 Gal.

o little is the difference between the exact content,
that found by the Diam. in the middle.

PROP. XIX.

nlarge or diminish a Circle, Square, or other Regular Figure at a Rate given.

he proportion (respecting the Rule) is: As one
n of the rate, to the Square of the Diameter or side
n; So the other term to the Square of the Dia-
er or side required: Therefore the root thereof is
Diam. or side demanded.

lso if you would enlarge; the less term of the Rate
st: if you would diminish. the greater is first.

xamp. 1. If 1000 Men lodge in a Square whose side
paces; How many paces shall the side of a Square
herein 5000 Men may so lodge?

ere the second Number being on the first or move-
Rule; it is most convenient to set 60 on the Sq.
line

line to 1000 in the middle of the Line of Numbe
againſt 5000 on the Line of Numbers is about 1
and ſo many paces muſt the ſide be.

Ex. 2. I would diminiſh a Circle, whoſe Diam is
f. at the rate of 8 to 5: Set 10 on the Sq. line to
the Line of Numbers; againſt 5 on the Line of N
bers is 7. 9 f. the Diam. required.

PROP. XX.

Having the Dimenſions of the parts of a Ship, which
the faſhion or ſhape; together with the Burthen ther
To find the Dimenſions of the ſaid parts for a Ship o
other Burthen greater or leſs, Retaining the faſhion
ſhape of the given Ship.

This Propoſition I find in Mr. *Norwood*;
wrought with great trouble. Since the inventio
the Logarithms by the Lord *Nepair*, (whoſe Name
never be forgotten) it is performed with great
either by the Line of Numbers, with a Cube-line,
ing a Line of a Triple Radius, adjoyned: or
exactly by the Logs. For want of the aforeſaid C
line, take this way by Compaſſes on the Line of N
bers.

Divide the Space between the burthen given,
that required into three equal parts. With this ex
Set one foot of the Compaſſes on each of the ſaid
menſions.

If the burthen required be greater than the gi
Turn the other foot forward to a greater Number:
leſs; turn it backward to a leſs Number: w
ſhall be the Dimenſions required. *Example.* in
and Tenths.

The burthen given	100 Tun.	Required	280 Tun.
	f.		*f.*
ength of the Keel	50.5		71.2
ength of the midſhip-beam	21.		29.6
epth of the Hold	9.		12.7
aking forw. of the Stern	13.5		19.
aking backw. of the Stern	4.		5.6

By the Logs. Subtract the Log. of the leſs Burthen om the Log. of the greater: The difference divide 3. The Quotient or third part add to or ſubtract m the Logs. of the ſeveral Dimenſions of the given ip: According as the Burthen required is, greater or s than the given; The Sums or Remainers ſhall the Logs. of the Dimenſions for the Burthen re-ired.

This, holding in the Dimenſions of Maſts, Yards, bles, Anchors, *&c.* muſt needs be of great uſe, be-ſo eaſily wrought; eſpecially to the Ship-wright; reeing him from groſs errour; and by it he may inſtructed to provide and order his Materials to the advantage.

The ART of PRACTICAL MEASURING Eaſily Perform'd, &c.

PART IV.

The Uſe of the double Scale of Numbers ſome Superficial Meaſures and Accoun

Directions.

1. IN the Rule of Three direct. If the ſec Number be greater than the firſt; the fou ſhall be greater than the third; and on the contrary.

But in the inverſe Rule: If the ſecond be gre than the firſt, the fourth ſhall be leſs than the thi and on the contrary.

2. If, ſetting the firſt to the ſecond, the third re eth beyond the Line; either remove the firſt to ſecond in the other length of the ſecond Line: take the third Number in the other length of firſt Line.

3. The ſecond and third Numbers are never t both on the ſame Line.

4. Obſerve well what Number goeth with the Q ſtion: for in the direct Rule, That, of the other t which agreeth with it in name or reſpect, is the f which you may ſet to either of the other.

As if the Queſtion be: If 32 Bricks pave one ſquare yard, how many Bricks will pave 12 yards? Here 12 is the third Number, and 1 the firſt; (both being of a name) which ſet to 12 or 32; againſt the other is 384 Bricks. But for the moſt part the firſt Numbers are given, as you will find after.

5. It is not hard to know the value of the fourth Number: for every Number on the Line increaſing or decreaſing in a Ten fold proportion; the nature of the Queſtion, or the thing meaſured will diſcover it. As in the Example above, the fourth Number may be 384, or 38.4, or 3.84. But it is evident, that it cannot be either of the two latter, much leſs 3840; ſo is it in any other.

PROP. I.

Multiplication, 1 being the firſt Number.

Sect. 1. *The Square.*

Multiply the ſide by it ſelf. Let the ſide be 14 f. Set 1 to 14; (beſt in the firſt length) againſt 14 on the firſt is 196 f. This is alſo found on the Sq. line.

Sect. 2. *The Long Square.*

Qu. 1. Multiply the longer ſide by the ſhorter. A Wall is 30 ½ f. long, and 16 f. high. Set 1 to 16; againſt 30 - is 488 f.

Qu. 2. A length is 42 f. the breadth 0 ¾ f. Set 1 to 2; againſt the Decimal .75 is 31 ½ f.

Qu. 3. How many Men are in a Body, where they ſtand 18 in front and 8 deep. Set 1 to 8; againſt 18 is 144.

Sect. 3. *The Triangle.*

Multiply the Baſe and Perpendicular, the one whole by half the other, which you will. In the Pike end of an Houſe: The overway is 18 f. The diſtance from the Pike to the overway (being the Perpendicular) 16.

Set 1 to 8; against 18 (as before) is 144 f. Or, Set 1 to either Perpendicular or Base; against the other is the Content.

Sect. 4. *The Trapezium.*

It is an irregular four-sided Figure. An irregular Plot (as of Land) before the Content can be found, is divided into these Trapezia, and Triangles.

To find the Content, draw a Line from one corner to his opposite one through the Trapezium: So as (if it may be) the two Perpendiculars falling from the other two Angles upon this Diagonal Line, (as they call it) may fall within the Trapezium: yet if one falls without, the Rule holds; but then the said Diagonal Line must be produced far enough.

So have you two Triangles having one common Base. Multiply this Base by half the Sum of the Perpendiculars; the Product is the Content of the Trapezium. Or set 2 to the Base; against the Sum of the Perpendiculars is the Content.

There is a Trapezium much used by the best Surveyors of Land, who, when they measure against a crooked limit, (be it Hedge, Ditch or River) carry their Chain strait from mark to mark; and taking Perpendiculars from the Chain to the bents, nooks or windings of the limit, describe Trapezia's in their Plot, have each two parallel sides, and two right Angles.

The Content is found, by multiplying half the sum of the parallel sides (being the perpendiculars,) by the neareſt distance between them, being the intercepted part of the said Chain-line; The Product is the Content.

So is measured any Trapezium, which hath two parallel sides, though the Angles be not right: But then one side must be continued, if need be: for this Line of neareſt distance must be perpendicular to the parallel sides.

Thus

Thus may the Rhombus and Rhomboid be measured, and infinite others neither æquilateral nor æquiangular.

Sect. 5. *Any Regular Figure.*

Whose sides being equal, the Angles are also equal. Multiply half the sum of the sides by the perpendicular let fall from the Center to one of the sides.

Example. A Table hath 6 sides: each side 2 f. the perpendicular 1.73 f. Set 1 to 1.73; against 6 is 10.4 f.

Sect. 6. *The Circle, and his Parts.*

1. The Superficial Content hereof is best found by *Prop.* 15. *Part* III. It is also found by multiplying half the Circumference by the Semi-diameter.

2. For the Semi-circle. Multiply half the Arch-line by the Semi-diameter.

3. The Sector, which is any part contained between two Semi-diameters and the Arch-line, is also measured the same way.

4. If a strait line be drawn through a Circle, not through the Center; it divides the Circle into two Segments. The measure of the less is thus. Measure the Sector, whereof the Segment is a part; then subtract the Content of the Triangular part: The remainer is the Content of the Segment. But in the greater Segment, the Content of the included Triangle must be added.

5. Having the Chord (*viz.* the strait line abovementioned) of a Segment, and the part of the Diam. intercepted between the Chord and the Arch; to find the whole Diameter.

As the intercepted part of the Diam. to half the Chord; so the said half Chord to the other part of the Diam. Add them and you have the whole.

6. The Diameter and Circumference are as 7 and 22. Set 7 to 22; against any Diam. is his Circumference. Set 22 to 7; against any Circumference is his Diameter.

Or having ſet 7 to 22; againſt the Circumf. on the ſecond is the Diam. on the firſt.

Sect. 7. *To reduce the aforeſaid Figures to Squares.*

Some of them, as the Triangle, long Square, *&c.* are reduced, as is ſhewn in the meaſure of Timber of ſuch Baſes: The other, as alſo any irregular Figure thus: Firſt, find the ſuperficial Content: Then ſet the Sq. line to his Squares, as is before taught, againſt the ſuperficial Content on the Line of Numbers is the ſide of the ſquare.

PROP. II.

Diviſion, wherein the Diviſor is the firſt Number.

Qu. 1. If 32 Bricks pave 1 ſq. yard; kow many yards will 500 Bricks pave? Set 32 to 500, or to 1; againſt the other is 15.6 yards.

Qu. 2. If 25 Trees coſt 21 *l*; what doth 1 Tree coſt? Set 25 to 21 being neareſt; againſt 1 is 0.84 *l* whereof the 8 is 16 ſhillings, and the 4 is 9 *d* $\frac{1}{2}$, as you will after ſee.

Qu. 3. The Content of a Rectangle or long Square being divided by one ſide; (whether the longer or ſhorter) The Quotient is the other. Suppoſe 144 Men placed 24 in Front, how many deep do they ſtand? Set 24 to 144; againſt 1 is 6.

PROP. III.

The Rule of Three direct.

Sect. 1.

When the length is meaſured in feet, the breadth in inches, and yet the content required in feet, 12 is the firſt Number, marked as 12 on the Sq. line, chiefly for the meaſure of Plank, or Board and Glaſs.

Qu. 1.

Qu. 1. A Plank is 36 ½ f. long, 18 inches broad: ſet 12 to either length or breadth, here to 18, being neareſt; againſt 36 ½ is 54 ½ f.

Qu. 2. A Board is 14 f. long, 26 in. broad: ſet 12 to 14; againſt 26 is 30 ⅓ f.

Qu. 3. A Pane of Glaſs is 2 ¼ f. long: 7.6 in broad: ſet 12 to 7.6; againſt 2 ¼ is 1.42 f.: which .42 is almoſt an half.

Sect. 2. *Sawyers Meaſure.*

They account 120 to the hundred: If you would know the Content of a ſtock of Plank or Board in ſuch Meaſure; having found the Content of one Plank or Board by the *Section* aforegoing; ſet 120 (repreſented by 12) to the ſaid Content, or to the Number of Karfes or Cuts, (which are always leſs by one than the Number of whole Boards in the ſtock) againſt the other are the Sawyers hundreds; which will fall in the ſecond length, except there be not one hundred foot in the ſtock. The Tenths are each of them 12 foot.

Examp. Admit there were 22 Boards in the ſtock mentioned *Qu.* 2. of the aforegoing *Section*; the Content of one Board is 30 ⅓. Set 12 to 21 the Number of Karfes; againſt 30 ⅓ is 5.31 near:

Which is 5 hundred and 37 f. For every tenth being as is ſaid 12 foot: If you ſet 10 to 12; againſt 31 is 37 and more.

Sect. 3. *Glaſs.*

It is moſt convenient in Glaſs to meaſure the length as well as breadth in inches: yet the Content being required in feet, .144 (repreſented by 1.44) is your firſt Number: and the Content, if a whole foot or above, in the ſecond length, as next before.

Examp. A Pane of Glaſs is 31 ½ in. long: 8 ½ broad: ſet 144 to 8 ½; againſt 31 ½ is 1.86 f.

Let there be 7 ſuch Panes: ſet 1 to 1.86; againſt 7 is 13 f.

Sect. 4.

Sect. 4. *By the Yard.*

In the following Queſtions both length and breadth are to be meaſured in foot meaſure. If the Content be required in yards, 9 is the firſt Number; there being 9 ſq. feet in a ſq. yard. So they meaſure Painting, Paving, Plaiſtering, Wainſcot, *&c.*

Examp. A length is 24 f. the breadth 10 ½: ſet 9 to 10 ½; againſt 24 is 28 yards.

Sect. 5. *By the Square of 10 Foot. As in Tiling, Flooring &c.*

Here 100 is the firſt Number. A Roof is 41 f. long and the Sparr 20 ½ f. Set 100 to 41; againſt 20 ½ is 8.4 Squares.

Sect. 6. *By the Sq. Rod at 16 ½ f. to the Rod, as in Brick-Walls.*

Here 272 ¼ (being the ſquare of 16 ½) is the firſt Number: Alſo 272, being cut on theſe Rules, may ſerve without conſiderable errour. A Wall is 110 long: 9 ½ f. high: ſet 272 to 110; againſt 9 ½ is 3.8 Rod, in the ſecond length. If you would have a mark at 324 the ſquare of 18: ſet 18 to 10; againſt 180 the ſecond mark the point.

Sect. 7. *By the Acre.*

In Land-meaſure 160 ſq. Perches, Poles, or Rods (commonly at 16 ½ f. in ſome places 18 f. to the Pole) make an Acre: Therefore 160 (repreſented by 16) is the firſt Number. The parts are 40 Pole to the Rood or quarter: 80 to 2 Roods: 120 to three. The lengths and breadths are meaſured in Poles.

Examp. 1. A length is 35 Perches: the breadth 19: ſet 160 to 19; againſt 35 is 4.15 Acres.

Examp. 2. A Triangular piece of Land hath the Base 24 Poles; the Perpendicular 16 ½: ſet 160 to 16 ½ againſt

ainſt 12 (half the Baſe) is 1.24 Acre near. Or ſet
o to the Baſe 24; againſt the perpend. 16 $\frac{1}{2}$ is 1.24
before.

PROP. IV.

The Inverſe Rule.

Here the Number that goeth with the queſtion is
firſt Number, which you may ſet to either of
other.

Examp. It ſeems 272 $\frac{1}{4}$ f. make a Rod of Brick wall
y at $\frac{1}{2}$ Brick thickneſs. If it be thicker, fewer feet
wer a Rod: If thinner, then more, at an Inverſe
portion.

f it be demanded how many feet anſwer a Rod (for
mple) at two brick thickneſs:

Set 2 (which goeth with the queſtion) to 1 $\frac{1}{2}$;
inſt 272 $\frac{1}{2}$ is about 204. *viz.* 204. $\frac{3}{4}$8 f. And ſo for
other thickneſs: which may be marked for firſt
mbers thus: ſet 1 $\frac{1}{2}$ to any thickneſs; againſt
$\frac{1}{4}$ on the ſecond mark the points.

PROP. V.

Fractions.

y Fractions I mean Decimals. A general Rule for
n is: ſet 10, or 100 to the Number of parts (that
e the whole) in the queſtion; againſt every Deci-
is its own ſhare or portion of the ſaid parts.

Sect. 1. *Of a Pound ſterling.*

The firſt figure after the prick in any Decimal of a
nd, is ſo many two ſhillings; double it therefore,
you have the ſhillings anſwering: 5 in the next
e is one ſhilling. Thoſe being accounted: ſet 100
4; againſt the remaining Decimal are the pence. If
e be not 5 in the ſecond place, having ſet as above,
inſt the other is the pence; the farthings being very
y eſtimated on the Rule.

Examp. Let .688 be the Decimal: The 6 is 12 *s.* and
the next 8, is 1 *s.* Set 100 to 24; againſt 38 the re-
ining Decimal is 9 *d*: in all 13 *s.* 9 *d.* Or

Or without the Rule thus: Having taken out t
ſhillings as above; if the remaining Decimal exc
not 30, account them farthings, abating one. If it e
ceed 30, take 25 out of it, which is 6 *d.* and the r
mainer account farthings, abating one.

Note, That the Decimal is ſuppoſed of three pla
at leaſt: If it be but of two; ſuppoſe a Cypher for t
third; and if there be more, you may neglect the
with the Caution in the like caſe before given.

So taking .25 out of .38, (in the Example above) t
remaining 13 account 12 farthings or 3 *d.* ſo the wh
is 9 *d.*

Sect. 2. *Of a Rod.*

At 30 *s.* the Rod what are 28 Cents: Set 100 to 3
againſt 28 is 8.4, *viz.* 8 *s.* and 4 tenths: Set 10 to 1
againſt 4 is 4 *d.* $\frac{3}{4}$: in all 8 *s.* 4 *d.* 3 *f.*

Sect. 3. *Of an Acre.*

How many Perches are 15 Cents of an Acre? S
100 to 160; againſt 15 are 24 Perches. More E
amples are needleſs.

Sect. 4. *Vulgar Fractions into known parts.*

Set the Denominator, being the lower, to his N
merator; againſt the Number of known parts in
whole is the Number of parts required. Or ſet
Denominator to the Number of parts; againſt
Numerator is his portion of the ſaid parts.

How many farthings are $\frac{5}{7}$ of a ſhilling? Set 7
48; againſt 5 is 34, or 8 *d.* 2 *f.*

Sect. 5. *Vulgar Fractions into Decimals.*

Set the Denominator to his Numerator; aga
100 is the Decimal required. What Decimal of a f
is $\frac{7}{12}$ or 7 inches: Set 12 to 7; againſt 100 is .58
enough, or .583.

The aforegoing Examples being well underſto
it will not be difficult to apply the double Scal
any other ſubject.

The ART of PRACTICAL MEASURING Easily Perform'd, &c.

PART V.

SECT. I.

The Diagonal Scale. (Fig. III.

It consisteth of 21 Equidistant Parallel Lines thorough the length of the Scale: and of Transverse Parallels at a quarter of an inch distance one from the other: with 5 Diagonals thorough the uppermost Inter. In the Parallel of 10 there is a Cypher at every Transverse. This row of Cyphers divides the whole Scale into two Scales, having one Diagonal Integer of both.

It is fitted chiefly to *Gunter*'s Chain, which is accounted the best for surveying of Land; and is of 16 Inches in the Inch.

If the place of Tens in the Links be 0, 2, 4, 6, or 8; (the last four whereof are set against their respective Diagonals) use the first or left hand Scale. But if the place of Tens be 1, 3, 5, 7, or 9; use the second or right hand Scale. For that Diagonal, which is 20 (for Example) in the first, is 30 in the second; that which is 40 in the first, is 50 in the second, &c.

Examp.

Examp. 1. Let 10 Chains and 46 Links be requ
from the Scale: ſet one foot of the Compaſſes on
long Parallel or Link line, repreſenting 6 in the t
Chain-line or Tranſverſe, and firſt Scale: and ex
the other to the Diagonal 40, in the ſaid Link-
of 6.

2. But to take off 10 Chains and 56 Links: ſet
foot on the Link-line of 6 in the ſaid tenth Chain-
and ſecond Scale: and extend the other to the ſ
Diagonal in the ſaid Link-line of 6; ſo have you
Lines required.

3. So having a Line on your Plot; to know h
many Chains and Links it is: Take it with your C
paſſes, and carry it parallel to the Link-lines: one
in one of the Chain-lines, and the other thorough
Diagonal Integer, till it falls on one of the Diagon
And according as it falls in the firſt or ſecond S
ſo account the Tens of your Links.

The Scale may be made to 20 in the Inch; (as
commonly to 12, and ſet on the other ſide) w
muſt needs exceed any plain Scale of that dimen
for exactneſs.

Sect. 2. *Gunter's Chain.*

It is 4 perches long at 16 ½ f. to the perch: T
make 792 inches. It hath 100 links; ſo each link
7.92 in.

Thoſe Chains Mr. *Warner* ſells, are diſtinguiſ
with pieces of Braſs at every tenth link; which pi
contain ſo many corners or points as they ſignifie
of links from either end of the Chain. As thus: T
Braſs at 10 links has one tippet or point; that at
has two; that at 30, 3; that at 40, 4; and the ſ
again from the other end, but at 50 in the middle,
large round piece of Braſs, and at 25, from each
two Curtain-Rings together. By the help of t
diſtinctions (which are plainer and far more vi
than the old way of Rings alone) you will ſpee
find the number of links.

Althou

Although the Chain be divided into 4 perches, by the two double Rings, and the large brass Circle in the middle, so that it may be applied to the Measure of any length by the *Pole*; yet in measuring lengths in Surveying, we take notice only of Chains and Links, not concerning our selves with perches till we cast up the Content.

To multiply a length and breadth measured with this Chain, Reduce them into Links, which is no more trouble than to set the Links at the right hand of the Chains; or if there be no Links, to put two Cyphers there: So 4 Chains and 32 Links are 432 Links, and 7 Chains are 700 Links.

Having multiplied a length by a breadth, the sixth figure of the Product to the left hand (if there be so many) is Acres compleat; the seventh, Tens of Acres.

Exam. 1. If you multiply 5 Chains and 82 Links by 3 Chains and 21 Links, the Product is 1.86822, whereof the 1 is one Acre.

Ex. 1.

	582
	321
	582
	1164
	1746
	1.86822

Also 13 Chains and 42 Links by 8 Chains and 70 Links: The Product is 11.67540, where-of the 11 is eleven Acres. The Decimals are reduced to Roods and Perches as followeth.

Ex. 2.

	1342
	870
	93540
	10736
	11.67540

Sect. 3. *To reduce the Decimal Links of* Gunter's *Chain into Poles.*

An Acre is 160 square Perches, as hath been said, equal to 100,000 square Links of this Chain; which being divided by 160, the Quotient 625 is the square Links of one Perch or Pole. This as it is the Decimal of an Acre, ought to be expressed thus .00625;

as alſo all other, *viz.* with 5 places, except it be ev
Tens; for a Cypher or Cyphers at the left hand are
no value, as hath been ſaid.

The parts of an Acre are firſt 4 Roods; wherefo
4 is your firſt Multiplier. And there being 40 Pole
a Rood, 40 is your ſecond.

Or if you multiply your Decimal by 160, t
figures remaining to the left hand, after the Decim
be cut off, are Perches immediately.

But where the Content is not exacted to half a Po
we uſually take this ſhorter courſe without prefi
Cyphers.

It is evident, that if the places of the Decimal
but three, there cannot be two Poles. If they be fo
multiply the firſt figure by 6: If five, multiply
two firſt places by 6: In both, ſet the Product
place back toward the right hand; then add toge
the firſt or two firſt places (reſpectively) of the D
mal and Product ſo ſet; adding alſo a Unit for e
6 that ſhall be in the figures of the next place,
Sum is the Number of Poles in the Decimal.

See here two Examples; one of four places, the other of five. Alſo you ſee how the Products are placed and added.

Ex. 1. *Links* 8
4
Poles 1

Ex. 2. *Links* 21
12
Poles 3

In the firſt there is once 6, in the ſecond twice 6 in the figures of the next place; for which 1 in the firſt and 2 in the ſecond are added to the other. The two place
the right hand are neglected, as never amountin
the ſixth part of a Pole.

The reaſon of this Operation, Mr. *Wingat*
whoſe Arithmetick I firſt met with it, uſed al
Mr. *Atwell*, as you may ſee in his Book of Surve
Printed *Anno* 1662, which I value beyond moſt B
of that Subject Printed ſince) deeming it not
ob

vious, leaves to the ſearch of the curious. Take here.

1. If 100 (which are ſo many thouſand Sq. Links ing an Acre) require 60 to be added to it, to make 160 Poles, being alſo an Acre; what ſhall any other mber of thouſands of ſq. Links require to be added it, to turn it into Poles?

2. To multiply a Number by 6, and divide the Pro- t by 10, gives the ſame Quotient which you have multiplying the ſame Number by 60, and dividing Product by 100.

3. Setting the Product a place back to the right nd, both divides by 10, and ſeats it for *Addition.*

Sect. 4. *A Ready and Exact way by the Rule.*

On the double Scale, ſet 100 to 16; againſt the nks are the Poles anſwering. Neglect the two laſt ures, as is ſaid.

If the Decimal be 60,000 or more, take 5 out of firſt figure, accounting for it 2 Roods, and find Poles anſwering the Remainer: Let the Decimal .82511: Deducting 5. the Remainer is .32511. 100 to 16; againſt .325 is 52: *viz.* 1 Rood and Pole: ſo the Decimal is 3 *r.* 12 *p.*

t. 5. *Having the three ſides of a right Line Triangle; To find the Superficial Content.*

Add the three ſides together: from half the Sum ptract each ſide ſeverally, ſo you have three Re- ins; Multiply theſe three Remains and the half Sum ntinually, that is, the firſt Remain by the ſecond, t Product by the third, and this Product by the f Sum: The Square Root of this laſt Product is the erficial Content.

Moſt eaſily and ſpeedily by the Logs. thus: *Add* Logs of the three Remains and the half Sum to-

gether: Half the Sum is the Log. of the Superfi Content.

Examp. Let the sides be 1050, 854, 774. The h Sum is 1339; The three Remains 289, 485, 565; The Content is 3 *Acres*, 1 Rood, and 1 *Perch* near. This is the most certain way of measuring Land, where the Triangles can be measured in the Field, which otherwise are first plotted, and then cast up by the Base and *Perpendicular*, as hath been shewn.

1339	3.1267
289	2.4609
485	2.6857
565	2.7520
a.	11.0254
3.25640	5.5127
150	*a. r. p.*
41	3. 1. 01 ne

DIRE

DIRECTIONS IN DIALLING.

PART VI.

CAP. I.

The Use of a Diagonal Scale,

In laying down Angles, with the help of the Natural Sines, or for want of them the Artificial or Log-sines, applied to the putting the Hour-points on large Plains.

THE most convenient Scale for this purpose is that of 100 parts in the Inch. If you suppose the spaces between the long Parallels divided each into ten parts; They are Millesms or Thousand parts, which are the least that can be taken off the Scale. They are commonly made a foot long, and have on them ten Inches besides the Diagonal one, distinguish-

Alſo account the Radius or Sine of 90°.00′. to be 10.0000; ſo the firſt figure of all the Sines above that of 5°.44′. will be an Integer. That, and all under it to the Sine of 0°.34′. Decimals of the firſt Rate. That, and all the reſt, except the Sines of the three firſt Minutes of the ſecond; and thoſe of the ſaid three of the third.

The general Rule is,

As the Semi-radius. The Sine of 30°.00′, 5.0000
To the Semi-diameter;
So the Natural Sine of the half Arch
To the Chord of the whole.

Multiply the Sine of the half Arch and the Semi-diam. and prick off the Decimal in the Product: Then for the diviſion by 5.: Double the ſaid Product, and prick off one figure more to the Decimal; This is the Chord.

Examp. For the Chord of 40°.00′ to a Semi-diam. of 12 Inches. The Sine of 20°.00′. *viz.* 3.4202 multiplied by 12, the Product is 41.0424: This doubled and one place more prick'd off, is 8.20848, or 8 inches and 208 parts: which may be taken off the Scale for the Chord aforeſaid: The two laſt figures may be neglected.

If your Semi-diam. be not limited, it is done with far leſs trouble: For if you take 5 for your Semi-diam. the Sine of the half Arch is the Chord. If that be too little, Multiply 5 by any Number; and by the ſame multiply the Sine of the half Arch: The Product is the Chord. *Examp.* For the Chord of the ſaid 40°.00′ to a Semi-diam. of 30 inches, that is, ſix times five, multiply the ſaid Sine of 20°.00′. 3.4202 by 6: The Product 20.5212 is the Chord: The laſt figure may be neglected.

Note, That although you take only three places of Decimals from the Scale, yet in Multiplication for a larger Semi-diam. it is beſt to take four.

If the Minutes of the Arch, whose Chord you seek, odd, add half of the difference of the Sines of the o Minutes, between which the half Arch falls, to Sine of the less Minute The half difference you y find by view, without writing.

If you have not the natural Sines, you may find m by seeking the Log Sines in the Table of Logs. natural Numbers: The coresponden Number is the ural Sine, with this direction: If the Index of your g. Sine be 9, the first figure is an Integer; If 8, n the Number is a Decimal of the first rate: If 7, n of the second, &c. which is easily remembred.

CAP. II.

rections in the Use of the Tables of Logs. of Sines Tan- gents, and Natural Number, in order to the putting in the Hour-lines, and setting up the style in the most useful Plains.

The Log. of the Radius, *viz.* the Sine of 90°. or g. of 45°. is 10.00000. Therefore to add the Ra- s to a Log. Sine or Tang. (for only such are here nt, though called barely Sines or Tangents) is to e the Index of it Ten more than it is: To deduct abate the Radius, is to make the Index Ten less n it is.

. In the Canons or Rules following, if the first be Radius, add the Logs. of the second and third; Sum, (a Radius deducted) or neareſt to it, found the Tables, gives the Sine, Tang. or Number ght.

. If the second or third be the Radius, add them ther: Out of the Sum deduct the first; the Remain neareſt to it gives the fourth. Or rather, add the Compl of the first to that of the other two which ot the Radius: The Sum of both gives the fourth.

Note, That the Tang. Compl. or Cotang. is the Ar. mpl. of the Tangent, omitting the Radius; and is always

always in the ſame rank with the Tang. in the oth Column, or in the other Page, according as the Tabl are ordered.

3. If none of the three be the Radius, add the A Compl. of the firſt to the other two: The Sum of t three gives the fourth.

4. If there be many proportions to be wroug and the firſt and ſecond, or the firſt and third (wh in this caſe account the ſecond) hold always the ſam If the firſt be the Radius, write the ſecond in a pie of paper at the top near the edge; the figures equal thoſe of the Table you uſe; and holding it under t third Numbers in the Table, add them in a Colu in another paper.

5. If the ſecond or third be the Radius, write t Ar. Compl. of the firſt, and uſe it in every reſpect before.

6. If none of the three be the Radius, write difference of the firſt and ſecond ſo; and holding i the other, add, if the firſt were the leſs; but ded if the ſecond were the leſs. Or if you had rather a write the *Ar.* Compl. of the difference, and add it.

7. If the ſecond and third hold the ſame, write Sum of them at the bottom of a piece of paper near edge; and holding it over the firſt Numbers in Table, deduct the ſaid firſt Numbers.

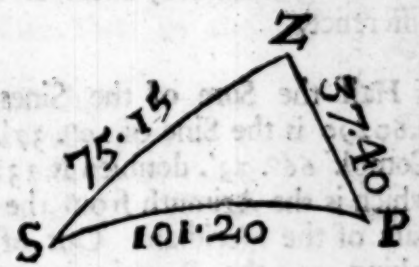
There are alſo proportions where the Numbers figurate; whereof here followeth an Example in fi ingthe Hour and *Azimuth.*

But whereas in theſe there are ſometimes Sides *Angles* above 90°. ſo that the Complement to 1 muſt be uſed in their ſtead, I adviſe you (for ſav that trouble) to write the degrees above 90 on the of the Table, in the left hand column or page, near printed degrees. *As*, near gr. 0, write 90: near gr write 91: near gr. 10, write 100: and ſo the reſt order, as far as you think you may have occaſion; ways obſerving, that you uſe the Minutes under

written Degrees; but the Sines themſelves take in other column or in the other page, being the Comments of theſe. So if you would uſe the Sine of 91°. . in *Gellibrand*'s Tables, ſeek the 20'. under gr. 1; take the Sine againſt it in the right hand page, *viz.* 99.88, the Sine of 88°. 40', as alſo of 91°. 20'.

CAP. III.

ing the Latitude of the Place, the Declination and Altitude of the Sun, to find the Hour and Azimuth.



the Triangle Z P S repreſenting the Zeor point over head Pole, and Sun. The ZP is the Compl. the Lat. Z S the mpl. of the Alt. S P diſtance of the Sun the Pole, which in the Summer half year is the mpl. of the Declination, but in the Winter half is his Declination with 90 degrees added. Alſo angle at P is the hour, that at Z the Azimuth.

et the ſides be as in the Example, the hour inquired. Add the ſides: n half the Sum take the ſide oppoto the inquired Angle, and note the rence.

o the Ar. Compl. of the Sines of ſides comprehending the inquired le, add the Sines of the half Sum, of the difference: Half the Sum is Co-ſine or Sine Compl. of half the inquired Angle.

	° ′
	101.20
	75.15
	37.40
S.	214.15
H.S.	107.07
	75.15
Dif.	31.52

The

The half Sum of the Sines, *viz.* 9.96268 you will find to be the Sine of 66°. 35′: whose Compl. 23°. 25′. doubled is 46°. 50′. This turned into time is 3 hours and 7 minutes from Noon; that is, 7 minutes before 9 or after 3.

Note, That 15 degrees make an hour, and 15 m of a degree 1 min. of time.

For the *Azimuth* in this Example: the half Sum is the same; but another side being deducted, there is another difference.

H. 107.
101.
D. 5.

Half the Sum of the Sines, *viz.* 9.60290 is the Sine of 20°. 37′. whose Compl. 66°. 23′. doubled is 132°. 46′, which is the Azimuth from the North part of the Meridian. Out of which taking 90, the Remain is 42°. 46′. and so many degrees the Sun was past the East point, or short of the West, at the time of that Observation.

.213
.008
9.980
9.722
19.925
9.962

.21
.01
9.98
8.99
19.20
9.60

CAP. IV.

To find the Declination of a Plain.

IN order to which take this Table of the Refraction of the Sun in mi-
es, corrected by the Parallax, as far
16°. alt. The uſe is, Take the mi-
es againſt the degrees, each out of his
ective degree, ſo have you his Alt.
from Refraction. *Alſo* it is not u-
l to make any Obſervation in this
after Ten, or before Two of the
ck.

2. Take a Board that hath a ſtrait
On a Center in a Diam. parallel to
ſide, and about half an inch or more
it deſcribe a Semi circle. Divide
into two Quadrants; each Quadrant
90, and ſubdivide it as you think
Number it with 10, 20, 30, *&c.*
each end of the Diam. to 90. *Alſo*
ay be convenient to number the de-
es on either ſide of 90 double; that
at 80, ſet 100; at 70, 110, *&c.* The part without
ſemi-circle may be cut off.

3. *Apply* the ſtrait ſide to the Plane, ſo as the ſuper-
es thereof may be exactly horizontal or level. Hang
hred with a *Plummet* ſo as it may caſt a ſhadow on
Centre; when the ſhadow is on the Centre mark
degree cut by it in the ſemi-circle: *At* the ſame
e let another take the *Altitude* of the Sun with a
adrant or other Inſtrument.

4. Having found how many degrees the Sun is ſhort
or paſt the Eaſt or Weſt point, ſet off that point
ich is on the *Plane* backward or forward reſpective-
rom the degree cut by the ſhadow, or point; The
degrees

Alt. Degr.	*Refr.* Min.
0	31
1	23
2	17
3	14
4	12
5	11
6	10
7	9
8	8
9	7
10	7
11	6
12	6
13	5
14	5
15	4
16	4

degrees intercepted between the Diam. and the
point are the degrees of the Declination of the Pl
which is either East or West, according to the p
that is on the Plane.

5. It may be convenient in some cases to set off
South point from the degree cut by the shadow,
the Compl. of the *Azimuth* to 180: Then 90 deg
forward or backward will be the East or West poi

Note. That instead of the semi-circle divided on
Board, it may be more convenient (at least for
riage) to have one so divided upon stiff paper, or pa
royal, for then any Board, having a strait side,
a Line drawn near and parallel to that side, being
plied to the Wall as above, you may direct the
dow any where toward the middle of the said s
side: And at the time of observation of the *Alt.* of
Sun, make two pricks in the line of shadow, the
distant from the other as far as conveniently you
Then taking the Board from the Wall, joyn the
points in a line drawn at full length, and apply
Centre of your semi-circle in the point of interse
of the line of shadow with the parallel line on
Board, and the Diam. exactly on the said parallel li
so the line of shadow will shew the degree to be u
in every respect as in *Paragr.* 4. of this Chapter.
may take two or more Observations, but then be c
ful to apply the *Azimuth* each time to his proper
gree in the semi circle.

Otherwise.

Upon a Board of about 8 inches broad, exa
plained, let a semi-circle of about seven inches s
diameter be drawn and divided as above. Let a b
Index about an Inch broad be fitted to turn upon a
in the Centre, having a point in the middle of the e
which may move round just by the Divisions or
mongst them.

Let the end be as the Fi-
re in the Margin : the di-
nce from A to B two in-
es at the leaſt.

From the point let a Fi-
cial line be drawn thorough
e Centre, and near the point
the ſaid Line, let there be
ole for a ſmall thread or
eſtring, hollowed under-
th for the knot of the ſaid
ing.

Fix another Rule to this
about ſix inches long, and
breadth of the other, at a
ht angle, a little behind the Centre, with Screws
an ordinary ſight is fitted to the Index of a plain
ble.

Placing it on the Centre, and the point at 90 ; a-
n a point in the top, which muſt be equidiſtant from
ther end of the Diam. or from any two points there-
equidiſtant from the Centre. Through this point
ll a hole, and through it draw a fiducial line down
meet the other line.

Let this Rule have a notch in the ſide near the bot-
n for a Plummet to be hung from the top, whereby
Board may be placed Horizontal.

Strain a ſtring through both the holes and the Board
ng ſo placed, turn the Index to the Sun, till the
dow of the ſtring fall into the fiducial line of both
es; and the degree pointed, note as before, &c.

CAP. V.

To find what Alt. the Sun hath when he is due East or W

As the Sine of the Lat.		°
To the Sine of the	*Sine of* 52.20 *Ar. Com.*	.10
Suns Decl.	*Sine of* 23.30	9.60
So the Radius	*Sine of* 30.15 *the Alt.*	9.70
To the Sine of the Alt.

So in the Lat. of 52°. 20'. and Decl. 23°. 30'. Alt is 30°. 15'.

And so for any other Lat. and Decl. If it be a Summers day, and you wait till the Sun cometh to Alt. the degree cut by the shadow is the East or W point.

CAP. VI.

The Declination of the Sun.

The Sun's place in degrees and minutes for every at Noon is in all Ephemerides, and in some Almanacks yearly: From whence his distance from the Æquinoctial point being known, his Declination found by this Canon:

As the Radius

To the Sine of the Suns greatest Decl. 23°. 30'

So the Sine of his distance from the next Æquinoctial point.

To the Sine of his Declination.

But in case those should be wanting, I have joyned Tables of his Declin. for every day at N for four years together, with the years over the they are in Sir *Jonas Moor*'s new system of the Mathematicks, which will hold for some years forward. for their further continuance I have adjoyned a T of Seconds, taken out of Mr. *Wright*'s Correcti Errors in Navigation. by the help of which they be rectified, so as to serve for many years to come.

C

CAP. VII.

To find the Ascensional Difference, or the time of the Suns Rising or Setting from Six.

As the Cotang. of	☉'s		
Lat.	*Cotang. of* 52.20	*Ar. Compl.*	11241
To the Tang. of	*Tang. of* 23.30		9.63830
Suns Decl.			
So the Radius	*Sine of* 34.17		9.75071
the Sine of the Ascensional Dif.			

So in the Lat. of 52°. 20′. and greatest Declination, Ascensional difference is 34°. 17′. which in time is 17m. wherefore the earliest Hour-line is that of a rter before 4; and the latest a quarter after 8, which ht to be on the Dials of that Lat. except they be de to half quarters or minutes, as some Horizontal ls are.

CAP. VIII.

The Horizontal Dial.

s the Radius
To the Sine of the Lat.
the Tang. of the Hour in the Table following,
o the Tang. of the Arches of the Hour-line from the Meridian.

Write the Sine of the Latitude, as is before directed; holding it under the Tangents of the hours, add n in a Column against their own hours. Seek them he nearest among the Tangents; the Degrees and utes answering are the said Arches or Arks of the e; which set down in another Column, every one nst his own Tang.

Draw a line on the Plane for the Meridian or hour 2, and the Substylar: In it choose a Centre; out which describe an occult Circle; in which set off said *Arks* of the Plane from the Meridian on either ; which may be done by a line of Chords, or a

Protractor, (these Dials being for the most part small) or by a small Diagonal Scale as is before shewn. Lines drawn from the Center through these points shall be the hour-lines.

The hour-line of 6 crosseth the Meridian in the Centre at right angles. And the hour-lines before 6 in the Morning, and after 6 in the Evening may be supplied, by continuing their opposite hour-lines beyond the Centre to the other side.

The Style must be put up in the Centre over the Meridian at an angle equal to the Lat. of the place.

These are commonly made in Brass, and the Style is a Brass Plate; which being of a considerable thickness, the two edges cast the shadow, each on the hours next it. So the Dial is in two parts separated by a space equal to the thickness of the Style. But note that the shadow is cast upon the continued lines before and after 6, from the opposite edge of the Style, whereof care must be taken.

The Dials following are supposed to be made upon Board or Plank with Lead and Oyl, and to be fixed after they are made. The Style a round Iron rod. It

A TABLE

Of the equal Distan of the Hours in D grees and Minute from 12, for the H rizontal and Ver eal Dials; from for the East and W Dials, being the A gles at the Pole.

12	0
.	3 . 45
X	7 . 30
.	11 . 15
11.1	15 . 0
.	18 . 45
X	22 . 30
.	26 . 15
10.2	30 . 0
.	33 . 45
X	37 . 30
.	41 . 15
9.3	45 . 0
.	48 . 45
X	52 . 30
.	56 . 15
8 4	60 . 0
.	63 . 45
X	67 . 30
.	71 . 15
7 5	75 . 0
.	78 . 45
X	82 . 30
.	86 . 15
6	90 . 0

It is beſt to prime them on both ſides together, and to hang them ſo as a ſmall Gale may turn the ſides ſucceſſively to the Sun, otherwiſe they may be drawn from the exactneſs to which they ought to be made. Paint them thrice.

CAP. IX.

The Eaſt and Weſt Dial.

There is no difference in the making of theſe two. The Hour-line of *6* is the Subſtylar; which muſt croſs the Æquinoctial line of the Plane at right angles.

This Line muſt be drawn at full length; and the shape of the Dial ought to be an Oblong rather than a juſt Square.

The Hour-points may be prickt in the Æquinoctial line from the Natural Tangents of the Hours in the Table, taken from a Diagonal Scale, on either ſide from *6*, *viz.* on the upper ſide according to the Aſcensional difference: On the lower ſide to 11. or 1. They are ſeldom put on further, for the great diſtance of the other quarters, and 12 cannot be put on.

If the Natural Tangents be wanting, they may be found in the Table of Log. Numbers, as is before directed for the Nat. Sines.

The Style muſt be parallel to the Subſtyl. The height, in this caſe, as the Tang. of 45, *viz.* 10, which is alſo the diſtance of *9* and *3* from the Subſtyl. The hour lines are all parallel to the hour of *6*. and ſo to one another; the Æquinoctial-line cutting them all in the middle.

This Line muſt be croſſed ſomewhere by an occult line at an angle equal to the Lat.; which in the fixing muſt be a Perpendicular or Plumb line, (it pointing to the Zenith, from whence the Æquinoctial is diſtant according to that angle;) by means whereof the Æquinoctial-line of the Plane will be adjuſted to the true height.

If the Plane be a fixed Plane, this Vertical, Perpendicular or Plumb-line must be first drawn by help of a Thread and Plummet; and then the Æquinoctial line at the said angle, and then the Substyl and the other Hour-lines as before.

But in large Planes, To proportion the distance of the Hour-lines, and the Style, to the Plane:

As the Sum of the Nat. Tangents of 75°, and of the Ascensional difference,

To the length of the Æquinoct. line in Inches;

So the Nat. Tang. of the Ascen. difference

To the distance of the Hour-point of 6 from the upper end of the line.

And so is 10

To the height of the Style.

In the Lat. above-named, the Nat. Tang. of the Ascen. diff. is 6.817. That of 75°. 37.32. The Sum 44.137. Let the Æquinoct. line of the Plane within the border be 32 inches: The distance of the Hour-point of 6 from the upper end of the said line will be 4.94 inches, and the height of the Sty	44.137	*Ar. Compl.*	8.355
	32.		1.505
	6.817		.833
	4.942		.693
	44.137	*Ar. Compl.*	8.355
	32.		1.505
	10.		1.
	7.25		.860

and distance of the third hour 7.25 in. Then,

As the Tang. of 45°.

To the height of the Style;

So the Tang. of the Hours in the Table belonging to this Plane,

To their distance from the Substyl. Which gathered into a Table as is directed in the Horizontal Dial.

The further Hours from the Substyl. ought to be longer than the nearer, or the Style of a sufficient length, lest the shadow thereof at some time or other of the Day or Year goeth off the Plane. This Dial must be set in the Plane of the Meridian.

CAP. X.

The Prime Vertical, or full South upright Plane.

Placing the Dial as it must be fixt, or if it be fixt: Draw a Vertical Line for the Meridian, or Hour of 12, and the Substylar. Toward the upper part choose a Centre, where cros the said Line at right angles with the Hour-line of 6.

As the Radius
To the Co-sine of the Lat.;
So the Tang. of the hour in the Table
To the Tang. of the Hour-line from the Meridian.

Which having gathered into a Table; out of the Centre describe an occult Semi-circle, and inscribe these Arches (as you will be directed in the next) from the Meridian on either side.

The Style must be put up in the Center over the Merid. at an angl. equal to the Compl. of the Lat. for which you will have large and plain Directions afterward.

CAP. XI.

The Vertical Decliner, or the upright declining Plane, The South face.

In making this most useful Dial, after the Declination found,

1. We enquire the Inclination of the Merid. of the Plane to that of the place.

As the Sine of the Lat.
To the Radius;
So the Tang. of the Planes Declination
To the Tang of the Inclination of the Meridians. Which assigns the place of the Substyl. among the Hours.

2. The height of the Pole above the Plane.

As

As the Radius
To the Co-ſine of the Lat.
So the Co-ſine of the Decl.
To the Sine of the ſaid height, which is the heig
of the Style above the Subſtyl'ar.

3. The Diſtance of the Subſtyl. from the Merid.

As the Radius
To the Sine of the Declination;
So the Cotang. of the Lat.
To the Tang. of the diſtance.

Look into the Table of Hours for Vertical Dials. If the Inclination of the Meridians be any of the Degrees and Minutes in the Table, whether whole Hour, half, or quarter, write the figure or mark thereof reſpectively in the middle of a half ſheet of Paper, near the left hand ſide, in a narrow Column, and write againſt it *Mer. Subſtyl.* Then fill up the Column upward and downward with the Hours, Halves and Quarters, as they ſtand in the Table to ſix Hours each, with this Direction; If the Declination be Eaſt, place the Morning Hours: If Weſt, the Evening Hours about the Subſt. As in this Example, where the Incl. falls on the half hour paſt 10, the Decl. being Eaſt.

In another Column againſt the Quarters, above and below *Mer. Subſtyl.* write 3.45: againſt the next 7.30, and ſo the reſt as in this Table. Theſe are the angles at the Pole.

.	48.45
X	45.0
.	41.15
1	37.30
.	33.45
X	30.0
.	26.15
12	22.30
.	18.45
X	15.0
.	11.15
11	7.30
.	3.45
X	*Mer. Su*
.	3.45
10	7.30
.	11.15
X	15.0
.	18.45
9	22.30
.	26.15
X	30.0
.	33.45
8	37.30
.	41.15
X	45.0
	&c.

If the Incl. falls not on a quarter, ſet down *Mer. Subſt.* as before, in the middle, and continue the quarters between which it falls, upward and downward to ſix Hours in ſuch a narrow Column.

Take the quarter in the Table of Hours next leſs than the Incl. out of the ſaid Incl. The Remain ſet againſt the ſaid quarter in another Column. Then take the Remain out of 3.45; this Remain ſet againſt the quarter on the other ſide of *Mer. Subſt.* in the ſaid Column.

By a continual addition of 30.45'. to theſe Remains, make up each row towards 90. not above: Theſe are the Angles at the Pole. See the ſecond Example, where the Incl. is between three quarters paſt Two, and Three: the Decl. Weſt.

In the continual addition of 3.45, ſorten your work thus: add only thrice above and thrice below; ſo you have the four firſt quarters on each ſide. Then to the firſt add 15 degrees, (for the minutes alter not:) Then to the ſecond, and ſo to the reſt; which you may do by Inſpection. So have you two Hours on each ſide. Then beginning again, add 30 degrees to the firſt, and continue your addition of 30 in order, till it amounts to 90. not above. This is ſo eaſie, as you may account it as faſt as you can write.

	&c.
.	53.25
X	49.40
.	45.55
12	42.10
.	38.25
X	34.40
.	30.55
1	27.10
.	23.25
X	19.40
.	15.55
2	12.10
.	8.25
X	4.40
.	0.55
	Mer. Sub.
3	2.50
.	6.75
X	10.20
.	14.05
4	17.50
.	21.35
X	25.20
.	29.05
5	32.50
.	36.35
X	40.20
.	44.05
6	47.50
.	51.35
	&c.

Having

Having the angles at the Pole,

As the Radius

To the Sine of the height of the Style;

So the Tang of the angle at the Pole

To the Tang. of the *Arks* of the *Plane* from the Subſtyl. to the Hour-points. To attain which, take the courſe directed in the Horizontal Dial, by writing the Sine of the height, *&c.*

Set down the Tangents, every one againſt his own angle in another Column.

In a fourth ſet down the degrees and minutes anſwering theſe Tangents: Theſe are the *Arks* of the *Plane*.

In order to the finding the Chords belonging to theſe *Arks*; in a fifth Column ſet down the halves of theſe *Arks*. If the degrees be odd, ſet down the leſs half and add 6 to the place of Tens in the minutes, and then halve them.

If the minutes of the whole be odd, note it in the half by annexing 5 at the right hand of the minutes.

In a ſixth, the Chords to the Semidiam. 5.

In a ſeventh, the ſaid Chords multiplied to any other Semi-diam. according to the largeneſs of the *Plane*, and as you have uſe of them.

Ex Of a *Plane* declining Eaſt 12° 45'. Lat. 52°.20

	° '		
Sine of	52 . 20	*Ar. Compl.*	.1015
Tang. of	12 . 45		9.3546
Tang. of	15 . 57	*Incl. Mer.*	9.4561
Coſine of	52 . 20		9 7860
Coſine of	12 . 45		9.9891
Sine of	36 . 35	*Height of the Pole.*	9 7752
Sine of	12 . 45		9.3438
Co-Tang. of	52 . 20		9.8875
Tang. of	9 . 40	*Diſt of Subſt.*	9.2313

Pa

Part of the Table on each ſide the Subſtyl.

Hour.	An. Pol.	Tangents.	Ark. Pl.	H. Ark.	Co. for 5.	For other
.	34.42	9.61561	22.26	11.13	1.9452	
1	30.57	9.55316	19.46	9.50	1.7078	
.	27.12	9.48615	17.02	8.31	1.4810	
X	23.27	9 41251	14.30	7.15	1.2620	
.	19.42	9.32919	12.03	6.015	1.0495	
12	15.57	9 23131	9.40	4.50	.8426	
.	12.12	9.11012	7.21	3.405	.6409	
X	8.27	8.94715	5.04	2.32	.4420	
.	4.42	8.69020	2.49	1.245	.2457	
11	0.57	7.99489	0.34	0.17	.0494	
Mer.	Subſtyl.					
.	2.48	8.46461	1.40	0.50	.1454	
X	6.33	8.83526	3.56	1.58	.3432	
.	10.18	9 03468	6.11	3.055	.5393	
10	14.03	9.17363	8.29	4.145	.7395	
.	17.48	9.28184	10.50	5.15	.9440	
X	21.33	9.37176	13.15	6.375	1.1536	
.	25.18	9.44983	15.44	5.52	1.3687	
9	29.03	9.51989	18.19	9.095	1.5916	
.	32.48	9.58444	21 01	10.305	1.8237	
X	36.33	9.64525	23.50	11.55	2.0649	

To Draw this Dial.

Placing it as it muſt be fixt, Draw a Vertical or lumb-line in or near the middle; (if the Decl. were eat, leave moſt ſpace on the Subſtyl. ſide) for the eridian.

In this Line near the top chooſe a point for the Cen-e; and draw an Arch out of it, at as large a Semi-am. as the Plane will bear.

In this Arch ſet off the Subſtyl. from the Meridian, the left hand, the Decl being Eaſt, (but if Weſt on e right,) and draw it at full length through the Cen-and this point.

Suppoſe

Suppoſe this ſemi-diam. 35 inches. The Chord
the Table againſt 12 (which is always the ſame w
the diſtance of the Subſtyl. from the Merid.) is .8
which multiplied by 7, (for ſo many times 5)
Product 5 8982 taken off the Scale (the laſt fig
neglected) and prick'd down in the ſaid Arch on
left hand of the Merid. giveth the point; throu
which and the Centre the Subſtyl. muſt be drawn.

From this point ſet off the Chords, multiplied re
ctively, in the ſaid *Arch* on either ſide. If the Ch
exceed not 11 inches, it is on the Scale: But for
greater, open the Compaſſes to ten inches, and ſe
many of the ſaid diſtances in the Meridian Line fr
the Centre, as it will bear, and note or account th
10, 20, 30, *&c.* So when any Chord is above 10,
30, *&c.* take the exceſs off the Scale, and ſet it do
in this Line from the point which it exceeds; and w
a pair of Large or Beam-Compaſſes, take the wh
Line from the Centre to this point. When the Ch
go off the *Plane*, take a Semi diam. ten inches leſs.

Note, It is moſt convenient to ſet off the Sub
from the Merid. at as large a Semi-diam. as the M
dian Line will bear, by the firſt Direction in the
Chapter: But the hour-points at as large a Semi-di
of fives as the ſaid Line will bear at firſt, and
leſs.

There ought to be no Hour-lines above the H
zont Line that croſſeth the Merid. at right *Angle*
the Center, in the South faces of theſe *Planes*, altho
ſome points on the Subſtyl. ſide reach beyond it;
there being always a border at the top, and the Se
diam ſmall, you may perhaps ſet off a point or
above it; and drawing a Line from them beyond
Center, have their oppoſite points. But take a g
ral Rule.

Take the half *Arks* of the uppermoſt and lo
quarters in your Column, each out of 45: The Su
the Remains, add to the laſt half *Ark* on that ſide

wants: Seek the Chord, mul iply it, (if there be cauſe) nd ſet it off from the Subſt as before. If more be anting, take the difference of the laſt, and laſt ſave ne on the Subſtyl. ſide: *Add* it to the laſt Sum, and nd the Chord, *&c.* and ſo proceed by taking the difference between the two next, adding it to the laſt, and nding the Chord till all be ſupplied.

Having put on the points, you may deſcribe the order. Draw alſo two Lines parallel to the border; ne inmoſt for the half hours, the other for the quarers, at convenient diſtances.

Then you may deſcribe a large Semi-circle out of the Centre for the whole Hour-lines. If the Declination e ſo great, as it cauſed you to ſet the Merid. near one de, let it be an *Arch* greater than a Quadrant, or as r as about the middle between the Merid. and the borer; and draw a Line from the end thereof parallel the Merid. up to the above-mentioned Horizontal ne. *Alſo* croſs the Subſtyl. in the Center at right *An*es with a ſhort Line.

Pierce the Centre perpendicular to the Plane with a apering Bit, till the Diam. of the hole be equal to e breadth of your Hour-line. Fill the hole with a und Peg, that may be about a quarter of an inch ave the *P*lane; and thereon hang a fine Thread or uteſtring, by a nooſe ſo large, as it may turn round the *Peg*: Stretch this ſtring juſt over the Hourints, and with a pair of dividing Compaſſes opened the breadth of the Hour-line, make two pricks near e border, intercepting the Thread juſt in the middle, d ſquare to the ſaid Thread.

Then laying a Rule to the Peg and the point anſwer, draw the Line from the Semi-circle to the bor- for the whole Hours; but for the halves and quar- s only from their reſpective Lines, and ſo go round. n turn the Rule the other way, and applying it to anſwering point, draw the other ſide of the Line he ſame manner: Then fill it with ſome colour.

CAP. XII.

To find what Hours the Sun shineth on the North face of any upright Plane.

1. IF the face be direct North; ° '

As the Tang. of *Tang.* 52.20 *Ar. Com.* 9.88759
the Lat. *Tang.* 23.30 9.63839

To the Tang. of the *Cos.* 70.23 9.52598
Suns greatest Declination;

So the Radius,

To the Cosine of the hour from the Merid. in which the Sun is due East or West.

In the Lat. of 52°. 20′ the time is 18′. after 7 in the Morning, and as many before 5 in the Evening. The Morning Hours before, and the Evening Hours after must be on the Plane.

If the Plane declines:

As the Cotang. of the Suns greatest Declination

To the Cotang. of the Lat.;

So the Cosine of *Cotang.* 23.30 *Ar. Compl.* 9.63[illegible]
the Inclination of *Cotang.* 52.20 9.88759
the Meridians, *Cosine* 15.57 9.98291

To the Cosine *Cosine* 71.10 9.50881
of an Angle, Which added to that of the Inclination the Sun turned into time is the hour and minute from Noon, in which the Sun leaves the Plane before Noon, or comes on it after Noon, (as the Plane respects the East or West) for the fewer hours: The difference is the time, as above, for the more hours. The Morning Hours before, and the Evening Hours after must be on the Plane.

In the Example of the Plane before-mentioned, the Decl. of the South Face being toward the East, the North Face is toward the West; therefore the more Hours are after Noon. The Sun is 87°.07′. The Sun in the longest Day leaves the Plane 12′. after 6

the Morning: The difference is 51°. 13′; therefore he comes on it again 19′. before 4 after Noon. Wherefore the Hour-line of 6 and all before must be on one side; and a quarter before 4, and all after on the other.

3. If the Declination of the Plane be greater than the Amplitude in the greateſt Declination: The Sun ſhines on the Plane only before Noon, or only after Noon reſpectively. The Amplitude is the diſtance, in Degrees and Minutes of the Horizon, of the Sun's Riſing or Setting from the Eaſt or Weſt points, and is thus found,

As the Coſine of	*Coſine of*	52.20	*Ar. Compl.*	.21391
the Lat.	*Sine of*	23.30		9.60070
To the Radius;	*Sine of*	40.44	*Ampl.*	9.81461
So the Sine of the Suns Decl.				

To the Sine of the *Ampl.* So in the Lat: of 52°.20′. and greateſt Decl. The *Ampl.* is 40° 44′.

In theſe North faces the Style points upward. In a direct North Plane, draw firſt an occult or obſcure Vertical Line through the middle of the Plane, for the Merid. and Subſtyl. Croſs it at right Angles, lower than the middle, with the Hour-line of 6. The interſection is the Centre. The Hour-lines are drawn as in the South face. The Hours that fall below 6, muſt be drawn from their oppoſite Lines, continued beyond the Centre, as in the Horizontal Dial.

The Morning Hours are on the right hand of the Meridian, when the Dial is placed as fixt: The Evening on the left.

In the North-eaſt faces, the *Afternoon* Hours in the Table of Hours muſt be ſet above and beneath *Mer. Subſt.* and ſo continued upward and downward, and the Subſtyl. on the right hand of the Meridian, when the Dial is placed as above. In the North-weſt faces, the contrary in both reſpects.

In the greater Decliners more ſpace muſt be left on the Subſtyl. ſide, and care muſt be taken to leave ſufficient ſpace for the hours that fall below the Centre.

When the Declination of the Plane exceeds the greateſt *Ampl.*; the inſide of the border may be the Meridian.

CAP. XIII.

Directions for great Decliners.

In both faces of theſe upright Planes, the greater the Decl. is the nearer the Hour-lines fall together.

Where they fall ſo near together, as you can ſcarce diſtinguiſh them, it is beſt to leave out the Centre.

Wherefore draw the Dial at large upon Paper or Paſtboard: If it be for a ſmall Dial, (as in a Pane of Glaſs) ſet off alſo the Style, according to its due height on one ſide of the Subſtyl. So you may cut out as much thereof in a Square or Oblong as will fit your Deſign. And prick it down upon your Plane, and ſet the Style up at the heights anſwering the parts cut off, without more trouble, than to draw an occult Line parallel to the Merid. in any place convenient, (before you cut it out) for the due placing thereof.

But for a large Plane, it is beſt to draw the Dial by two Tangent Lines, as followeth.

In your large Draught above-mentioned you may omit moſt of the inward Hours, and the trouble belonging to them, more than the Tangents of the Ark of the Plane.

Deſcribe a ſmall Square, the ſide parallel to the Merid. in a convenient place in your Draught, which may contain all or moſt of the Hour-lines and the Subſtyl.

Let the large Draught be A B D E. (*Fig.* IV.) The ſmall Square G H D F. Within this ſmall Square draw two parallel Lines perpendicular to the Subſtyl, ſo as they croſs all the Hour-lines, and yet be diſtant one from the other as far as the Square will permit, viz. O P and Q R.

Meaſure

Measure the side of the small Square, and the length of the Substy. from the Centre to the points of Intersection with both these Lines. These lengths are Semi-diameters, and the cross Lines Tangents to them.

Measure also the neareſt distance of the point of Intersection of the Semi-diam. and Tang. fartheſt from the Centre, from each side of the Square next to it, as NI and LI.

Example.

Lat. 52°. 20'. Decl. West 82°.30. The side of the small q. 8 in. .4 The Semi-diameters CI and CM 17 in. and 12 in. .16 Dist. of I from FD, *viz.* LI 3 in. 6, the Dist. thereof from HD. *viz.* NI 2 in. The de of the Plane, whereon the Dial is to be drawn, ithin the border, supposed a Square 32 inches. *As* e side of the little Square, to the side of your Plane, the length CI to the larger Semi-diam. of your ane. *And*, so the length CM to the less Semi-am. of your Plane. *And*, so the Distances LI d NI to their answering respective Distances in ur Plane.

To find which the neareſt way; Take the difference the Logs. of 8.4 and 32. *viz.* .58087 and add it to Logs. of the third Numbers; the Sum shall give length of the Lines belonging to your Plane, according to the 6th Direction, *Cap.* 2*d.* The Semi-di-. CI will be 65.53. Semi-diam. CM 46.32. The tance LI 13.18. *And* the distance NI 7.62. *Also* difference of the Semi-diameters, *viz.* the Line MI 9.21 inch.

Coming now to your Plain, fix the Point I accord-to his own Distances; wherein there is no need of ctneſs.

Through it draw an occult Vertical answering to K L. Out of I as a Centre, and as large a Semi-diam as the Plane will bear, describe an occult Arch of a Circle from the Vertical on both sides. In it inscribe the distance of the Substyl. from the Meridian, and draw the Substyl. at full length through I and this point. Set off the Compl. of the distance on the other side of the Vertical, to make up a right Angle. Draw a Line at full length through this point and the Centre I: It shall be the greater of the two Tangents.

From I set off the difference of the Semi-diameters in the Substyl toward the Centre of the Dial to M. Through this point draw the less Tang. parallel to the other.

As the Tang. of 45
To the length of each Semi diam.;
So the Tang of the Ark of each Plane
To his respective distance of the Hour-point from the Substyl. And,
So the Tang. of the height of the Style
To his respective height above the Substyl.

These you may obtain with much ease and speed by holding the written Log. of each Semi-diam. To the Tangents of the Arks of the Plane before found, and adding them, *&c.* according to the first Direction, *Cap.* Having gathered these Distances into two Columns against their respective Tangents, set them off from the Substyl. in their proper Tang. Lines, and joyn the points with Lines continuing them beyond the points to the borders.

Then set up the Style over the Substyl. at the two heights assigned: Or rather choose another point in the Substyl. nearer to the Centre, and find the height answering, by the length of the Semi-diam. to it; and set it up accordingly.

The Directions of Mr. *Gunter*, concerning these great Decliners, being very short, I have made them as plain as I can; and by the help of the Diagram, they

re freed from the difficulty, which without it would ave attended them.

CAP. XIV.

Directions in putting up the Style in Dials that have their Centres on the Plane

This depending on the Solution of a right line Triangle, it will not be amiss to premise the usual Canons, hereby it is resolved. Noting first, That

1. In every right-line Triangle, the three Angles e equal to two right ones or 180 degrees. Therefore one Angle be known, the Sum of the other two is nown, and two being known, all are known.

2. In a right-angled Triangle, the right Angle being o°; the other two are Complements, each of the her. Therefore if one be known, the other is also nown.

3. The greater side is always opposite to the greater ngle, and on the contrary.

Prop. 1.

In a right-angled Triangle: If you make either side t the right Angle the Radius, the other is the Tang. his opposite Angle. Therefore,

As the Tang. of 45°.
To the known side;
So the Tang of the Angle opposite to the inquired side
To the inquired side.

Prop. 2.

In a right-angled Triangle: If you make the side. posite to the right Angle the Radius, the other sides the Sines of their opposite Angles. Therefore,

As the Radius
To his opposite side;
So the Sine of either of the other Angles
To his opposite side.

Prop. 3.

Prop. 3.

In any Triangle, the ſides are proportional to t Sines of their oppoſite Angles. Therefore the Angl and one ſide known:

As the Sine of any Angle given
To the oppoſite ſide;
So the Sine of either of the other Angles
To his oppoſite ſide.

So, having two ſides and an Angle oppoſite to eith of them, the other Angles may be found, and the thir ſide.

Prop. 4.

In any Triangle: Having two ſides, and the *Angl* comprehended by them, to find the other two *Angles* and the third ſide.

As the Sum of the ſides
To their difference;
So the Tang. of half the Sum of the unknown *Angle*
To the Tang. of half their difference.

The Sum of the half Sum and half difference is th greater *Angle*, and their difference is the leſs. Havin all the *Angle*; the third ſide may be found by th *Prop.* next before.

Prop. 5.

Having the three ſides, to find the *Angles*.

As the Baſe, the greater ſide,
To the Sum of the other ſides;
So the difference of the other ſides
To a fourth Number; which being taken out o the Baſe, the Perpendicular will fall on the middle o the Remainer. So you have two right-angled Trian gles, in each two ſides known, and the right *Angle* op poſite to one of them; from whence the other *Angle* and the third ſide may be found by the ſecond part o *Prop.* 3.

A far better way after the manner of finding the ur and Azimuth before delivered.

From half the Sum of the three ſides deduct each e ſeverally,

To the Ar. Compl. of the Logs. of the half Sum and the difference of the ſide oppoſite to any inquired gle, add the Logs. of the other two differences: lf the Sum is the Log. Tang. of half the inquired gle: Then you may repeat the latter part of the rk for one of the other Angles; or find them both *Prop.* 4.

To put up the Style.

1. Add 90°. to the height thereof: Protract that gle, and let one end of the Style be turned, as near you can to it. This turned part muſt not be full ſo g as the Dial is thick. Let it be ſomewhat tapering, h a Skrew at the end, and a Nut fitted to it, to be in to the back of the Dial. Let the other end be nded to a blunt point.

2. For the due length of the Style as relating to the ur; take the length of the longeſt Hour-line on the ſtyl. ſide of the Plane, from the Centre to the inner der, whether it be whole Hour, half or quarter to tenth of an inch, which is ſufficient in this caſe:) and e the Angle at the Pole belonging to it.

As the Radius

To the Coſine of the *Angle* at the Pole;

So the Cotang. of the height of the Style

To the Tang of a firſt *Angle*.

The ſhadow of the Style being ſhorteſt in the great-Winter Declination of the Sun on the South faces of e upright Planes; but in his greateſt Summer De-ation in the North faces,

d 23° 30′ to this *Angle*; The Sum is a ſecond gle.

As

As the Cosine of 23°. 30',
To the Sine of the second *Angle*;
So the length of the Hour-line
To the length of the Style.

Note, If the Sun be beneath the Horizon at the h belonging to the longest Hour-line, find the Decli tion of the Sun answering the *Ascensional* differe of the said hour, by a converse of the Canon, *Ca viz.* as the Radius, to the Sine of the *Ascensional* ference;

So the Cotang. of the Lat to the Tang of the Dec This Declination use in every respect as you are di cted to use the greatest, and you shall have a shor yet sufficient length of the Style.

3. *Assign* a point in the Substyl. at a convenient stance from the border, wherein to fix a Suppor Then by *Prop.* 1.

As the Tang. of 45°.
To the length of the Substyl from the Centre this point;
So the Tang. of ~~the height~~ of the Style,
To the length of the Supporter. To which m be allowed more for the greater part of the Eye Hole, in which the Style must rest, (which may somewhat Oval:) *Also* must be allowed at the o end near as much as the thickness of the Plank, fixing it. The part to be driven into the Dial le Square, strong, and a little tapering, but not to a po with a shoulder above it for the driving it: Let i made of good Iron, somewhat slender toward the that it may be bent or wrested any way for the due justing the style.

4. Draw or raze a short Line in the middle of style on each side, which may point strait out a turned end.

5. Having pierced a hole for the Supporter, d it near to its depth. Put the style through it, and fin turned end into his place at the Centre, till the

es before-mentioned fit exactly to the ſhort Line, ected to be drawn through the Centre perpendicu- to the Subſtyl. *Cap.* 11

6. But to adjuſt it to the true height and place, e the juſt length of it from the Centre. Then by p. 2.

As the Radius
To the length of the Style;
So the Coſine of the height
To the diſtance of the point in the Subſtyl. from Centre, perpendicularly under the end of the le. *And*,
So the Sine of the height
To the diſtance of the end of the Style from the point.

7. In the largeſt *Arch* of the Plane, ſet off at a con- ient equal diſtance two points, from the point of rſection with the Subſtyl.

8. If the Style be ſo placed, that the end thereof (where the Style is long) a point marked in the dle of the upper ſide thereof, (near Perpendicular he ſaid point of interſection) be ſet at an equal di- ce from theſe two points, and the end of the Style kept at his due diſtance from the point in the Sub- right under it (either by driving or bending the porter, or both as you ſee cauſe) it ſhall be truly ed. Then skrew on the Nut, but not too hard.

9. In ſome Dials (North faces eſpecially) the Style d to the due length, may reach beyond the Plane. or the ſetting the Style to the juſt height, you ld find the diſtance of the end of it from a point n near the end of the Subſtylar. The length of Style and the diſtance of the ſaid point from the re are two ſides of a Triangle, comprehending a wn *Angle*, *viz.* the height of the Style. So the of the other two *Angles* being known by *Prop.* 4. may find both theſe *Angles*; and by *Prop.* 3. the l ſide, which is the diſtance ſought. But it is placed

placed best over the Substyl. by marking a point in top of the Style, and proceeding according to the mer Direction.

CAP. XV.

To find the Altitude of the Sun at every Hour in a Day in the Year.

1. IF the Sun be in the Æquator,
As the Radius
To the Cosine of the Latitude;
So the Cosine of the Hour from the Meridian
To the Sine of the *Altitude*.

2. If the Sun hath Declination, the Meridian titude will be found by the Declination.

If the Hour be six:
As the Radius
To the Sine of the Latitude,
So the Sine of the Declination
To the Sine of the *Altitude*.

3. If the Hour be neither twelve nor six:

As the Cosine of the Hour from the Meridian
To the Radius;
So the Tangent of the Lat.
To the Tangent of a fourth *Ark*.

Then, If the Lat. and Declination be both alike with us in the North Lat. North Declination, and Hour be between Noon and Six, take the Declina out of the fourth *Ark*: The Remainer shall be a *Ark*.

But if either the Latitude and Declination be un or the Hour fall between Six and Midnight, add Declination to the fourth *Ark*; the Sum shall be fifth *Ark*.

Then, As the Side of the fourth Ark
To the Sine of the Lat.;
So the Cosine of the fifth Ark
To the Sine of the Altitude.

So for any one Latitude you may gather your fourth Arks into a Table, each against his own Hour; and against them in another Column the Differences between their respective Sines and the Sine of the Lat. so are they ready for Use. For having found the fifth Ark, you are only to subtract the difference out of the Cosine thereof; The Remainer is the Sine of the Altitude required.

Suns Declination.

Days.	Jan. South	Feb. South	Mar. South	Apr. North	May. North	June. North
1	21 41	13 42	3 20	8 40	18 7	23 11
2	21 31	13 22	2 56	9 2	18 22	23 15
3	21 21	13 2	2 32	9 23	18 37	23 18
4	21 10	12 41	2 9	9 45	18 51	23 21
5	20 58	12 21	1 45	10 6	19 6	23 24
6	20 47	11 59	1 21	10 27	19 19	23 26
7	20 34	11 38	0 59	10 48	19 33	23 27
8	20 22	11 17	0 34	11 9	19 46	23 29
9	20 9	10 56	0 10	11 30	19 59	23 30
10	19 56	10 34	No. 13	11 50	20 11	23 30
11	19 42	10 12	0 37	12 11	20 23	23 30
12	19 28	9 50	1 01	12 31	20 35	23 30
13	19 14	9 28	1 24	12 50	20 46	23 29
14	18 59	9 6	1 48	13 10	20 57	23 27
15	18 44	8 43	2 11	13 30	21 8	23 26
16	18 29	8 21	2 35	13 49	21 18	23 24
17	18 13	7 58	2 38	14 8	21 28	23 21
18	17 57	7 36	3 22	14 27	21 38	23 18
19	17 41	7 15	3 45	14 45	21 47	23 15
20	17 24	6 50	4 8	15 3	21 56	23 11
21	17 7	6 27	4 31	15 21	22 4	23 7
22	16 50	6 4	4 54	15 39	22 12	23 3
23	16 32	5 40	5 17	15 57	22 20	22 58
24	16 14	5 17	5 40	16 14	22 27	22 53
25	15 56	4 54	6 03	16 31	22 34	22 48
26	15 38	4 30	6 26	16 48	22 41	22 43
27	15 20	4 7	6 49	17 4	22 47	22 38
28	15 0	3 43	7 11	17 21	22 58	22 32
29	14 41		7 33	17 37	22 58	22 26
30	14 22		7 56	17 52	23 3	22 19
31	14 2		8 18		23 7	

An. 1681		1685		1689	
July	Aug.	Sept.	Oct.	Nov.	Dec.
North	North	North	South	South	South
22 4	15 6	4 27	7 21	17 43	23 8
21 56	14 48	3 54	7 44	17 59	23 13
21 47	14 30	3 31	8 6	18 15	23 16
21 38	14 11	3 8	8 29	18 31	23 20
21 28	13 52	2 45	8 51	18 46	23 23
21 18	13 33	2 21	9 13	19 1	23 25
21 8	13 14	1 58	9 35	19 16	23 27
20 58	12 54	1 35	9 56	19 30	23 28
20 47	12 35	1 11	10 19	19 44	23 29
20 35	12 15	0 48	10 40	19 57	23 30
20 24	11 55	0 24	11 2	20 10	23 30
20 12	11 35	0 1	11 23	20 23	23 30
19 59	11 14	So. 22	11 44	20 36	23 29
19 47	10 53	0 46	12 5	20 48	23 27
19 34	10 33	1 9	12 26	20 59	23 25
19 20	10 12	1 33	12 46	21 11	23 23
19 7	9 51	1 56	13 7	21 21	23 20
18 53	9 29	2 20	13 27	21 32	23 17
18 38	9 7	2 44	13 47	21 42	23 13
18 24	8 46	3 7	14 7	21 51	23 9
18 9	8 24	3 30	14 26	22 1	23 4
17 54	8 2	3 54	14 45	22 9	22 59
17 38	7 40	4 17	15 4	22 18	22 54
17 22	7 18	4 40	15 23	22 26	22 48
17 6	6 56	5 3	15 41	22 33	22 41
16 50	6 34	5 27	16 0	22 40	22 34
16 33	6 11	5 50	16 18	22 47	22 27
16 16	5 48	6 12	16 35	22 53	22 19
15 59	5 26	6 36	16 53	22 58	22 11
15 42	5 3	6 58	17 10	23 3	22 2
15 24	4 40		17 27		21 53

Suns Declination.

Days.	Jan. South	Feb. South	Mar. South	Apr. North	May North	June North
1	21 43	13 47	3 26	8 34	18 4	23 11
2	21 33	13 27	3 02	8 56	18 19	23 14
3	21 23	13 7	2 38	9 58	18 34	23 18
4	21 12	12 46	2 15	9 40	18 48	23 21
5	21 1	12 25	1 51	10 1	19 2	23 23
6	20 49	12 5	1 27	10 22	19 16	23 25
7	20 37	11 43	1 03	10 43	19 29	23 27
8	20 25	11 22	0 40	11 4	19 43	23 28
9	20 12	11 1	0 16	11 25	19 55	23 29
10	19 59	10 39	Nor. 4	11 45	20 8	23 30
11	19 46	10 17	0 31	12 6	20 20	23 30
12	19 32	9 55	0 55	12 26	20 32	23 30
13	19 18	9 33	1 19	12 46	20 44	23 29
14	19 3	9 11	1 42	13 5	20 55	23 28
15	18 48	8 49	2 05	13 25	21 5	23 26
16	18 33	8 26	2 29	13 44	21 16	23 24
17	18 17	8 4	2 53	14 3	21 26	23 22
18	18 1	7 41	3 16	14 22	21 36	23 19
19	17 45	7 18	3 39	14 41	21 45	23 16
20	17 28	6 55	4 03	14 59	21 54	23 12
21	17 11	6 32	4 26	15 17	22 2	23 8
22	16 54	6 9	4 49	15 35	22 10	23 4
23	16 37	5 46	5 12	15 53	22 18	22 59
24	16 19	5 23	5 35	16 10	22 26	22 54
25	16 1	4 59	5 58	16 27	22 33	22 48
26	15 42	4 36	6 21	16 44	22 39	22 42
27	15 24	4 12	6 43	17 0	22 45	22 36
28	15 5	3 49	7 05	17 17	22 51	22 29
29	14 46		7 28	17 33	22 57	22 22
30	14 27		7 50	17 48	23 2	22 14
31	14 7		8 12		23 6	

An. 1682 1686 1690

July		Aug.		Sept.		Oct.		Nov.		Dec.	
North		North		North		South		South		South	
22	6	15	11	4	23	7	15	17	39	23	7
21	58	14	53	4	0	7	38	17	55	23	11
21	49	14	34	3	37	8	1	18	12	23	15
21	40	14	16	3	14	8	23	18	27	23	19
21	31	13	57	2	50	8	46	18	42	23	22
21	21	13	38	2	27	9	8	18	58	23	24
21	11	13	19	2	04	9	30	19	12	23	26
21	0	12	59	1	40	9	52	19	26	23	28
20	49	12	39	1	17	10	13	19	40	23	29
20	38	12	20	0	53	10	35	19	54	23	30
20	27	12	0	0	30	10	57	20	7	23	30
20	14	11	40	0	7	11	18	20	20	23	30
20	2	11	19	So.	17	11	39	20	33	23	29
19	50	10	58	0	40	12	0	20	45	23	28
19	37	10	38	1	04	12	21	20	57	23	26
19	23	10	17	1	27	12	41	21	8	23	24
19	10	9	56	1	51	13	2	21	19	23	21
18	56	9	34	2	14	13	22	21	29	23	18
18	42	9	13	2	38	13	42	21	39	23	14
18	27	8	51	3	01	14	2	21	49	23	10
18	12	8	26	3	25	14	21	21	58	23	6
17	57	8	8	3	48	14	41	22	7	23	1
17	42	7	46	4	11	15	0	22	16	22	55
17	26	7	24	4	34	15	18	22	24	22	49
17	10	7	1	4	58	15	37	22	31	22	43
16	54	6	39	5	21	15	55	22	38	22	36
16	37	6	17	5	44	16	13	22	45	22	29
16	21	5	54	6	7	16	31	22	51	22	21
16	3	5	31	6	30	16	49	22	57	22	13
15	46	5	8	6	53	17	6	23	2	22	4
15	28	4	46			17	23			21	55

Suns Declination. 1683

Days.	*Jan.* South	*Feb.* South	*Mar.* South	*Apr.* North	*May* North	*June* North
1	21 46	13 52	3 31	8 29	18 0	23 10
2	21 36	13 32	3 8	8 51	18 15	23 13
3	21 26	13 12	2 44	9 13	18 30	23 17
4	21 15	12 51	2 20	9 34	18 44	23 20
5	21 4	12 31	1 57	9 56	18 59	23 23
6	20 52	12 10	1 33	10 17	19 13	23 25
7	20 40	11 49	1 9	10 38	19 26	23 27
8	20 28	11 28	0 45	10 59	19 40	23 28
9	20 15	11 6	0 22	11 20	19 52	23 29
10	20 2	10 44	Nor. 2	11 40	20 5	23 30
11	19 49	10 23	0 26	12 1	20 17	23 30
12	19 35	10 1	0 49	12 21	20 29	23 30
13	19 21	9 39	1 13	12 41	20 41	23 29
14	19 7	9 17	1 36	13 0	20 52	23 28
15	18 52	8 54	2 0	13 20	21 3	23 27
16	18 36	8 32	2 23	13 40	21 13	23 25
17	18 21	8 9	2 47	13 59	21 24	23 22
18	18 5	7 46	3 10	14 18	21 33	23 20
19	17 49	7 24	3 34	14 36	21 43	23 17
20	17 32	7 1	3 57	14 55	21 52	23 13
21	17 15	6 38	4 20	15 13	22 0	23 9
22	16 58	6 15	4 43	15 31	22 8	23 5
23	16 41	5 52	5 6	15 48	22 16	23 0
24	16 23	5 28	5 29	16 6	22 24	22 55
25	16 5	5 5	5 52	16 23	22 31	22 50
26	15 47	4 42	6 15	16 40	22 38	22 44
27	15 28	4 18	6 37	16 56	22 44	22 38
28	15 10	3 55	7 0	17 13	22 50	22 32
29	14 50		7 23	17 29	22 55	22 26
30	14 31		7 45	17 44	23 0	22 19
31	14 12		8 7		23 5	

1687 1691

July	Aug.	Sept.	Oct.	Nov.	Dec.
North	North	North	South	South	South
22 8	15 15	4 28	7 10	17 35	23 6
22 0	14 57	4 5	7 33	17 52	23 11
21 51	14 39	3 42	7 55	18 8	23 15
21 43	14 20	3 19	8 18	18 23	23 18
21 33	14 1	2 56	8 40	18 39	23 21
21 23	13 43	2 33	9 2	18 54	23 24
21 13	13 23	2 9	9 24	19 9	23 26
21 3	13 4	1 46	9 47	19 23	23 28
20 52	12 44	1 23	10 8	19 37	23 29
20 41	12 24	0 59	10 30	19 51	23 30
20 29	12 5	0 36	10 51	20 4	23 30
20 18	11 44	0 12	11 13	20 17	23 30
20 5	11 24	Sou. 11	11 34	20 30	23 29
19 53	11 3	0 35	11 55	20 42	23 28
19 40	10 43	0 58	12 16	20 54	23 26
19 27	10 22	1 27	12 36	21 5	23 24
19 13	10 01	1 45	12 57	21 16	23 22
19 0	9 40	2 9	13 17	21 27	23 19
18 45	9 18	2 32	13 37	21 37	23 15
18 31	9 56	2 55	13 57	21 47	23 11
18 16	8 35	3 19	14 17	21 56	23 7
18 1	8 13	3 42	14 36	22 5	23 2
17 46	7 51	4 6	14 55	22 14	22 57
17 30	7 29	4 29	15 14	22 22	22 51
17 14	7 7	4 52	15 32	22 29	22 44
16 58	6 44	5 15	15 51	22 37	22 38
16 42	6 22	5 38	16 9	22 43	22 31
16 25	5 59	6 2	16 27	22 50	22 23
16 8	5 37	6 24	16 44	22 56	22 15
15 50	5 14	6 47	17 2	23 1	22 6
15 33	4 51		17 19		21 58

Suns Declination. 168

Days	Jan.	Feb.	Mar.	Apr.	May	June
	South	South	South	North	North	North
1	21 48	13 57	3 13	8 46	18 10	23 12
2	21 38	13 37	2 50	9 7	18 27	23 16
3	21 28	13 17	2 26	9 29	18 41	23 19
4	21 18	12 56	2 2	9 51	18 55	23 22
5	21 7	12 36	1 39	10 12	19 9	23 24
6	20 55	12 15	1 15	10 33	19 23	23 26
7	20 43	11 54	0 51	10 54	19 36	23 28
8	20 31	11 32	0 28	11 15	19 49	23 29
9	20 19	11 11	0 4	11 35	20 2	23 30
10	20 5	10 50	North	11 56	20 14	23 30
11	19 52	10 28	0 43	12 16	20 27	23 30
12	19 38	10 6	1 7	12 36	20 38	23 29
13	19 24	9 44	1 30	12 56	20 49	23 28
14	19 10	9 22	1 54	13 15	21 0	23 27
15	18 55	9 0	2 18	13 35	21 11	23 25
16	18 40	8 37	2 41	13 54	21 21	23 23
17	18 24	8 15	3 5	14 13	21 31	23 20
18	18 9	7 52	3 28	14 32	21 40	23 17
19	17 53	7 29	3 51	14 50	21 49	23 14
20	17 36	7 7	4 14	15 8	21 58	23 10
21	17 20	6 44	4 38	15 26	22 7	23 6
22	17 2	6 21	5 1	15 44	22 14	23 1
23	16 45	5 57	5 24	16 2	22 22	22 56
24	16 27	5 34	5 47	16 19	22 29	22 51
25	16 10	5 11	6 9	16 36	22 36	22 45
26	15 51	4 47	6 32	16 52	22 43	22 39
27	15 33	4 24	6 55	17 9	22 39	22 32
28	15 14	4 1	7 17	17 25	22 54	22 25
29	14 55	3 37	7 39	17 41	22 59	22 18
30	14 36		8 2	17 56	23 4	22 10
31	14 16		8 24		23 9	

1688 1692

July	Aug.	Sept.	Oct.	Nov.	Dec.
North	North	North	South	South	South
22 2	15 1	4 11	7 27	17 48	23 9
21 54	14 43	3 48	7 50	18 4	23 14
21 45	14 21	3 25	8 12	18 20	23 17
21 35	14 6	3 2	8 35	18 35	23 21
21 26	13 47	3 38	8 57	18 50	23 22
21 16	13 28	2 15	9 18	19 5	23 26
21 5	13 9	1 52	9 41	19 20	23 27
20 55	12 49	1 28	10 3	19 34	23 29
20 44	12 29	1 5	10 25	19 45	23 30
20 32	12 10	0 41	10 46	19 01	23 30
20 21	11 49	0 18	11 8	20 14	23 30
20 8	11 29	Sou. 6	11 29	20 27	23 29
19 56	11 8	0 29	11 50	20 39	23 28
19 43	10 48	0 53	12 11	20 51	23 27
19 30	10 27	1 16	12 32	21 2	23 25
19 17	10 6	1 40	12 52	21 13	23 22
19 3	9 45	2 3	13 12	21 24	23 19
18 49	9 23	2 27	13 32	21 35	23 16
18 34	9 2	2 50	13 52	21 44	23 12
18 20	8 40	3 13	14 12	21 54	23 8
18 5	8 18	3 37	14 31	22 3	23 3
17 50	7 56	4 0	14 50	22 12	22 58
17 34	7 34	4 23	15 9	22 20	22 52
17 18	7 12	4 47	15 28	22 28	22 46
17 2	6 50	5 10	15 47	22 35	22 39
16 46	6 27	5 33	16 5	22 42	22 32
16 29	6 5	5 56	16 23	22 48	22 25
16 12	5 42	6 19	16 40	22 54	22 17
15 55	5 20	6 42	16 58	23 0	22 9
15 37	4 57	7 5	17 15	23 5	22 0
15 20	4 34		17 31		21 51

A TABLE of Seconds for rectifying the Table of the Suns Declination.

	Ja.	Fe.	Mar.	A.	M	Jun.	Jul	Au.	Sep.	Oct.	No.	De
	Se	Se	Se	Se	Se	Se.	Se.	Se.	Se	Se.	Se	Se
1	17	36	43	40	28	8	15	33	42	41	30	
2	18	37	43	39	28	7	15	34	43	42	29	
3	19	37	43	40	27	6	16	35	43	42	29	
4	20	38	44	40	27	5	17	35	43	42	28	
5	20	37	44	39	26	4	18	34	43	41	28	
6	21	37	43	39	25	4	19	35	43	41	28	
7	21	38	43	38	25	3	19	35	44	41	27	
8	22	39	43	38	24	2	19	35	43	40	6	
9	23	38	44	38	23	2	20	36	44	40	25	
10	24	38	45	37	23	1	21	36	43	40	4	
11	25	39	44	37	22	0	21	37	43	40	24	
12	25	40	44	37	22	1	22	38	43	39	23	
13	26	41	43	36	21	1	22	38	43	39	22	
14	26	40	44	36	20	2	13	38	44	38	21	
15	27	41	44	35	20	3	23	38	43	38	21	
16	28	42	43	35	19	4	24	39	44	37	20	
17	28	41	42	35	19	4	25	39	43	38	20	
18	29	41	43	35	18	5	26	39	43	37	19	
19	30	41	43	34	17	6	26	39	43	37	18	
20	31	42	42	34	17	7	27	40	43	36	17	
21	31	42	43	33	16	8	27	40	43	36	16	
22	32	42	43	33	15	8	28	41	44	35	16	
23	32	43	43	32	14	9	29	40	43	35	15	
24	33	43	42	32	14	10	29	41	42	34	14	
25	33	44	42	31	13	11	30	41	43	34	13	
26	33	44	41	31	12	12	30	41	42	33	13	
27	34	43	41	30	11	13	30	41	42	34	12	
28	34	43	41	29	10	13	31	42	42	33	11	
29	35	43	41	29	9	14	31	41	43	32	11	
30	35		41	29	9	14	32	42	42	32	10	
31	36		41		8		33	42		32		

The Uſe of the Table of Seconds.

We will ſuppoſe that the Tables of the Declin. were calculated for the four middle years, *viz.* 1685, 1686, 1687, 1688.

Subtract 1688 out of the year to which you would rectify the Declination.

The Difference divide by 4. If any Number remain, it ſhews in which of the three former years you muſt ſeek the Declination. If nothing remain, ſeek it in the laſt.

By the Quotient (being the Number of Leap-years paſt ſince 1688) multiply the Seconds found in this Table againſt the Day of the Month, in which you ſeek the Declination.

Divide the Product by 60. The Quotient add to the Declination in the Table, if the Declin. increaſeth, *viz.* in the Spring or Autumn Quarter; but deduct it if the Declin. decreaſeth, *viz.* in the Summer or Winter Quarters. The Sum or Remainer is the true Decl. for that Day at Noon.

Then for the Hours before or after Noon.

As 24

To the Difference of the Decl. in the Table in Minutes for one Day before or after;

So the Hour from Noon

To his proportional part, which muſt be added or deducted according as the Declin. increaſeth or decreaſeth; alſo with reſpect to the time before or after Noon.

Examp. I would know the Declination of the Sun at 7 in the Morning on the firſt Day of *April* 1723: Taking 1688 out of 1723, the difference is 35. which divided by 4, the Quotient is 8, and there remain 3: which ſheweth that you muſt ſeek the Declination in the third Table.

The Seconds in the Table are 40; which multiplied by the Quotient, the Product is 320. This divided by

by 60, the Quotient is 5: The Remainer may be le
ed in this case.

The Declination in the Table is 8°.29'. increasi
To which if you add the said 5, the Sum 8°. 34'. is t
Declination that Day at Noon.

The Difference for a Day before or after is 22. O
the double Scale: Set 24 to 22; against 5 the Ho
from Noon is 4.6 which you may call 5, for we r
gard not parts, as is before said.

This must be deducted out of the Declin. at Noo
because the Declination increasing, it is not amou
ed to that at Noon by so many Minutes.

To Gauge a Cask which is not full.

A Table for Gauging of Wine Casks which are not full.

G.	parts.	G.	partt.	G.	parts.	G.	parts.	G.	parts.
0	000	13	2630	26	4330	39	5913	52	7672
1	295		2703		4400		5976		7758
2	470	14	2775	27	4462	40	6040	53	7829
1	602		2847		4542		6094		7909
	720	15	2918	28	4585	41	6158	54	7990
2	830		2986		4646		6223		8072
3	935	16	3056	29	4706	42	6288	55	8154
	1038		3123		4766		6353		8236
4	1138	17	3189	30	4826	43	6418	56	8319
	1235		3255		4885		6483		8404
5	1329	18	3321	31	4943	44	6548	57	8491
	1420		3387		5000		6613		8580
6	1502	19	3452	32	5057	45	6679	58	8661
	1596		3517		5115		6745		8765
7	1681	20	3582	33	5174	46	6841	59	8862
	1764		3647		5234		6877		8962
8	1846	21	3712	34	5294	47	6944	60	9065
	1928		3777		5354		7012		9170
9	2010	22	3842	35	5415	48	7082	61	9280
	2091		3906		5476		7153		9398
10	2171	23	3960	36	5535	49	7225	62	9530
	2242		4024		5600		7297		9705
11	2328	24	4087	37	5662	50	7370	63	10000
	2405		4150		5724		7444		
12	2481	25	4213	38	5787	51	7519		
	2556		4270		5850		7595		

A Table of Meridional Parts.

Deg. Lat.	0	10	20	30	40	50	D
0	0	16	38	50	66	88	6,5
1	100	116	133	150	166	183	16,5
2	200	216	233	250	267	283	16,5
3	300	317	333	350	367	383	17
4	400	417	433	450	467	484	17
5	500	517	534	551	567	584	17
6	601	618	634	651	668	685	17
7	701	718	735	752	769	785	17
8	802	819	836	853	870	887	17
9	903	920	937	954	971	988	17
10	1005	1022	1039	1056	1082	1090	17
11	1107	1124	1141	1158	1175	1192	17
12	1209	1226	1243	1260	1277	1294	17
13	1311	1328	1345	1367	1380	1397	17
14	1414	1431	1448	1465	1482	1500	17
15	1517	1534	1552	1569	1586	1604	17
16	1621	1638	1656	1673	1690	1708	17,5
17	1725	1743	1760	1778	1795	1813	17,5
18	1830	1848	1865	1883	1900	1918	17,5
19	1936	1953	1971	1988	2006	1024	17,5
20	2042	2059	2077	2098	2113	2131	17,5
21	2148	2166	2184	2202	2220	2238	18
22	2256	2274	2292	2310	2328	2346	18
23	2364	2382	2400	2419	2437	2455	18
24	2473	2491	2510	2528	2545	2565	18
25	2583	2601	2620	2638	2657	2675	18
26	2694	2712	2731	2750	2768	2787	18
27	2806	2824	2843	2862	2880	2899	18
28	2918	937	2956	2975	2994	3013	19
29	3032	3051	3070	3089	3109	3128	19

A Table of Meridional Parts.

Deg. Lat.	0	10	20	30	40	50	
30	3147	3166	3185	3205	3224	3244	19
31	3262	3282	3302	3322	3341	3361	19
32	3380	3400	3420	3439	3459	3469	20
33	3499	3519	3519	3559	3579	3599	20
34	3619	3639	3659	3679	3700	3720	20
35	3740	3760	3781	3801	3822	3842	20
36	3863	3884	3904	3925	3946	3967	21
37	3987	4008	4029	4050	4071	4092	21
38	4114	4135	4156	4177	4198	4220	21
39	4241	4263	4284	4306	4327	4349	22
40	4371	4393	4414	4436	4458	4480	22
41	4502	4524	4546	4569	4591	4613	22
42	4636	4658	4681	4703	4726	4749	22
43	4771	4794	4817	4840	4863	4886	23
44	4909	4932	4956	4979	5002	5026	23
45	5050	5073	5097	5120	5144	5168	23
46	5192	5216	5240	5265	5289	5313	24
47	5337	5362	5386	5411	5436	5461	25
48	5485	5510	5535	5560	5586	5611	25
49	5636	5662	5687	5713	5739	5764	26
50	5790	5816	5842	5868	5895	5921	26
51	5948	5974	6001	6027	6054	6081	26
52	6108	6135	6162	6190	6217	6245	27
53	6272	6300	6328	6356	6384	6412	28
54	6440	6469	6497	6526	6555	6584	29
55	6613	6642	6671	6700	6730	6760	29
56	6790	6820	6850	6879	6910	6940	30
57	6970	7002	7031	7060	7094	7125	31
58	7156	7188	7220	7252	7284	7316	32
59	7348	7380	7413	7446	7779	7512	33

Deg	0	10	20	30	40	50	D
Lat	A Table of Meridional Parts.						
60	7545	7579	7612	7646	7650	7714	34
61	7748	7793	7817	7852	7887	7923	35
62	7958	7994	8029	8065	8102	8138	36
63	8175	8211	8248	8286	8323	8361	37
64	8399	8437	8475	8514	8553	8592	38
65	8631	8671	8710	8750	8791	8831	39
66	8872	8913	8960	8996	9038	9080	41
67	9123	9166	9225	9252	9296	9340	43
68	9384	9429	9474	9517	9565	9611	45
69	9657	9704	9751	9798	9846	9899	47
70	9943	9992	10041	10091	10141	10192	49
71	10242	10294	10346	10391	10450	10504	52
72	10558	10612	10666	10722	10777	10834	54
73	10890	10948	11006	11064	11123	11182	57
74	11242	11303	11365	11427	11989	11553	61
75	11617	11684	11747	11814	11881	11948	67
76	12016	12086	12156	12227	12299	12371	70
77	12445	12519	12595	12672	12749	12828	74
78	12907	12988	13070	13153	13237	13322	81
79	13429	13497	13586	13677	13765	13863	88
80	13958	14055	14153	14253	14355	14459	97
81	14565	14672	14782	14893	15007	15123	107
82	15243	15363	15487	15613	15241	15874	121
83	16009	16148	16289	16435	16584	16737	139
84	16894	17056	17222	17394	17570	17752	162
85	17940	18135	18336	18548	18761	18986	
86	19220	19464	19719	19986	20266	20560	
87	20870	21197	21545	21915	22310	22985	
88	23193	23692	24238	24842	25517	26282	
89	27165	28010	29488	31135	33460	37431	
90	Infin.						

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